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CHEMICAL ENGINEERING IN GREAT BRITAIN

IT was an Englishman, G. E. Davis, who, by his lectures in Manchester in 1887 and his world-famous book "A Handbook of Chemical Engineering" published in 1901, may well be regarded as the father of chemical engineering. British chemists and engineers refused to accept what they considered to be a hybrid profession, and the result was the appalling scarcity, revealed by the First World War, of men capable of designing and operating chemical plant for the manufacture of drugs, dyestuffs, explosives, etc. After that War, progress was slow, and training in Great Britain was haphazard for many years ; full appreciation of the value of the chemical engineer was left to the United States, where the profession made great progress.

An official expression of interest in chemical engineers in Great Britain in the form of a short but exceedingly informative report issued by the Ministry of Labour and National Service* is therefore very welcome. It has been prepared by a sub-committee of the Technical Personnel Committee under the chairmanship of Prof. A. M. Tyndall, and it sets out with great clarity the position of chemical engineers in Great Britain under the headings "The Training of Chemical Engineers", "Fields of Employment", "Estimates of Supply and Demand", and "Widening Possibilities of Employment".

The sub-committee explains at the outset that it has been faced with an unusual difficulty in forming estimates of the future demand for chemical engineers ; this is summed up in the words : "An appreciation that chemical engineering is a distinct technology has been and is growing but slowly in this country". How like the opening words of Davis's book written fifty years ago : "The functions of the chemical engineer are very generally misunderstood". There are still influential employers who either state definitely that they do not require chemical engineers, or hold the peculiar view that a chemical engineer is best produced by training him in some other branch of technology. A major problem before the sub-committee was consequently to estimate not only the obvious requirements for chemical engineers, but also the extent to which these die-hard employers might become converted, and for this reason it has not ventured on any predictions further ahead than five years.

The report details the ways which are open to a chemical engineer to secure professional status, and views with approval the fact that the different systems of training produce men with varying outlooks. One fact, to which the sub-committee does not direct attention, is that the first chemical engineering degree courses in Great Britain were started at two London colleges only in 1939, and owing to the Second World War have had insufficient time to develop in the manner intended. Because of the small number of

* Ministry of Labour and National Service : Technical and Scientific Register. Present and Future Supply and Demand for Persons with Professional Qualifications in Chemical Engineering. Pp. 24. (London: H.M. Stationery Office, 1950.) 6*d*. net.

students and shortage of staff, it was found necessary for the former to attend existing courses in chemical and engineering subjects. This procedure has also been adopted in other institutions, with not altogether satisfactory results; those who devised the course unanimously agreed that, chemical engineering being based on the fundamental principles of mathematics, physics and chemistry, these principles should first be explained, and students should then be shown how to apply them to the solution of practical problems and the design of new processes and plant. The subjects of the course must be carefully selected so as to show their interrelation, and teaching should be conducted by chemical engineers.

The report gives illuminating figures for the numbers of chemical engineers employed by the main groups of industries. As might be expected, the chemical industry heads the list with 864 in 1949, a figure which is expected to grow to 1,463 by 1954, although in 1938 it was only 286. Chemical plant manufacture is the second largest group. The average annual rate of expansion for the period 1938–49 for all industries was 10 per cent, and the same figure is expected in the period 1949–54.

This rapid development will require, in all, 1,310 new qualified chemical engineers during the five years, allowing for wastage. Against this, the estimated supply is 1,096, and this figure includes 240 men taking the Institution of Chemical Engineers examination. Many of these men are already employed as chemical engineers although not qualified, and in some cases others will be required to take their places. The great shortage disclosed by these figures is by no means the whole story; the deficit of about two hundred must be regarded as a minimum for two main reasons. First, the estimated number of those taking degrees probably represents in most cases the maximum that can be given instruction with existing accommodation and proposed extensions: it is by no means certain that the output will actually reach these figures. Secondly, it is quite clear that the number of new openings for chemical engineers is bound to increase rapidly in the near future, a point frequently emphasized in the report.

The sub-committee briefly discusses how the shortage could best be met, whether by founding new schools or by expanding those which already exist, and strongly favours the latter method. With this view, most chemical engineers engaged in teaching will agree; but the practical difficulties may not be fully appreciated. The success achieved by chemical engineers in the past is undoubtedly due largely to a rigorous selection before entry to the university and even more to the small size of the classes, which has made possible a close personal contact between the teacher and his students; about twenty would seem to be the largest number suitable for tuition of this kind. A similar number is roughly the maximum for practical work in the drawing office and laboratory and for visits to works. Any expansion to conform with this requirement cannot be gradual but must be by quanta, each quantum being a group of about twenty students working separately, except perhaps for formal lectures, and requiring a separate staff. This introduces a question not raised by the sub-committee as to who is to do the training. The report mentions a requirement of thirty lecturers to be recruited during the next five years, a figure which must seem to many to be on the low side. But how are even thirty to be obtained? The best men can command interesting and responsible posts in industry with high salaries, within a few years of leaving college; scarcely any consider the possibility of an academic career. A peculiar position thus arises in which the attractiveness of the profession seems likely to contribute to its extinction. Although the report of the sub-committee is most welcome to all chemical engineers, it is clear that the key to the fulfilment of its forecasts lies in the provision of incentives to attract a sufficient number of chemical engineers to the profession of teaching in the universities and other institutions of university standing in Great Britain.

PLANT PHYSIOLOGY AFTER SACHS

Fifty Years of Plant Physiology

By Prof. Th. Weevers. Pp. xi+308. (Amsterdam: Scheltema and Holkema, 1949.) n.p.

THE fifty years referred to in the title are those from 1895 to 1945 and they correspond very closely with the working life of the author. Prof. Weevers tells us in his introduction that it was in the former year that he entered the University of Amsterdam as a student under de Vries. The earlier date has also further significance. Sachs, who more than anyone else had been responsible for laying the foundations of modern plant physiology, died in 1897 and a phase in the development of the subject ended. Again, the "History of Botany" written by Sachs, which covered the period up to 1860, was continued by Reynolds Green to cover the next forty years, so that the year 1895 or thereabouts is a convenient time from which to continue that history further to the present time. Dr. F. W. Went, in an introduction to Prof. Weevers's book, suggests that this is Prof. Weevers's intention. However, the book is scarcely a history in the ordinary sense, though it might be regarded, as Dr. Went says, as a "Textbook of Plant Physiology on a Historical Basis". It scarcely emphasizes general trends of development sufficiently to be regarded as a history.

We are also told by Dr. Went that much stress is laid, deliberately, on contributions from the Netherlands. This is, of course, very understandable, and Prof. Weevers has every reason to be proud of the contributions made by his fellow countrymen, for we have come to regard the plant physiological laboratories of Holland as centres of research of the highest quality. It does, however, appear to have led to a certain lack of balance in the treatment of the subject. Thus quite a lot of space is rightly devoted to respiration; but Blackman's theory of oxidative anabolism is dealt with in a few lines and the implications of the theory scarcely indicated. Blackman's interpretation of his experimental findings may or may not have been correct; but there can be little question of the importance of the theory as a stimulant to further work. Again, in dealing with photo-

synthesis, the work of the Cambridge school under Blackman's direction receives rather brief mention, and some of it is not discussed at all; yet this was probably the most solid contribution to our knowledge of photosynthesis of the years under review. There is also no mention of the work of R. Hill on oxygen evolution by isolated chloroplasts; work which is now generally regarded as of considerable importance in the analysis of the photosynthetic mechanism. Another notable omission is found in the lack of any reference to the work of Gregory and Purvis on vernalization and photoperiodism, yet this is some of the most significant work which has been done in this field. One might also have expected some account of the long series of researches on seed dormancy and germination carried out under Crocker's direction at the Boyce Thomson Institute.

However, no one could deal adequately, in the space of some three hundred pages, with even the more important researches in plant physiology of the period under review, and we can readily forgive the omissions in Prof. Weevers's book in view of the very considerable amount of information which it contains. The various aspects of plant physiology are dealt with under eleven headings, of which, on the metabolic side, most space is devoted to respiration and mineral nutrition, the latter rather curiously including photosynthesis and nitrogen assimilation. Other chapters deal with imbibition and diffusion, water movement, translocation and the metabolism of heterotrophic plants. The last five chapters of the book deal with various aspects of growth and irritability, and here, in particular, the British reader is likely to find much information which is new to him.

"Fifty Years of Plant Physiology" should certainly be read with interest by all students of botany, and the reviewer will not be alone in feeling particularly grateful to Prof. Weevers for publishing his book in English.

W. Stiles

PHARMACOLOGY AND TOXICOLOGY OF URANIUM COMPOUNDS

Pharmacology and Toxicology of Uranium Compounds

With a Section on the Pharmacology and Toxicology of Fluorine and Hydrogen Fluoride. Edited by Dr. Carl Voegtlin and Prof. Harold C. Hodge. (National Nuclear Energy Series, Manhattan Project Technical Section, Division 6, Vol. 1.) Part 1. Pp. xviii+524. Part 2. Pp. iv+525–1084. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 2 Parts, 60*s*.

THIS volume is the result of several years of experimental investigation and study carried out by the Division of Pharmacology of the Manhattan Department of the University of Rochester. The prefaces and forewords themselves will be found useful to the uninitiated in the understanding of such mysterious terms as Manhattan Project, etc. The historical foreword is a mine of information in itself and should serve as a lucid example of the manner in which toxicological investigations should be planned, while the introduction of thirty-seven pages is, in fact, an excellent and valuable summary of the whole. The major portion of the first volume deals with the pharmacology and toxicology of uranium and its compounds, while the remainder is a useful review of the pharmacology and toxicology of fluorine and hydrogen fluoride.

The initial aim of these investigations was to determine the potential hazards to man of the use of uranium on a scale hitherto unknown, and it is most striking throughout that, although experimental animals were under investigation, at no time has this aim been lost sight of. Throughout the whole work, the implications of experimental findings are clearly and concisely discussed in regard to their importance to man.

The chemistry of numerous uranium compounds is considered, especially with regard to their mechanism *in vivo* and the importance of such vital phenomena as the formation of anionic complexes. Analytical methods are lucidly outlined, and the necessity for the application of statistical procedures to results discussed. A brief, but extremely useful, review of statistical methods and their meaning is included and should be read by anyone who desires to understand the results of experimental investigations fully and yet has not the necessary background of statistics to do so. The chapters dealing with the histopathology and mechanism of uranium poisoning stress the fact that uranium is essentially a nephrotoxin, and that the urinary excretion of catalase, phosphatase and protein are the only reliable indexes of poisoning.

Toxicity studies were made following the administration of uranium compounds by various routes, and the overwhelming importance of the inhalational route is stressed, since lung absorption exceeds by many times the absorption from any other location. The relative toxicity of various uranium compounds when administered by inhalation is outlined in a most useful table (Fig. 2, p. 40), where it is shown that uranium hexafluoride is probably the most toxic and pitchblende the least toxic compound.

The relationship between particle size, lung retention and solubility of uranium dusts is logically discussed with reference to toxicity, and the importance of these factors, when applied to human exposure, is considered at some length. With regard to the question of solubility, it is emphasized that the solubility of a given dust in water is not necessarily the same as that in tissue fluids; for example, uranium peroxide, although very insoluble in water, was discovered to be fairly soluble in serum and, therefore, proved to be a highly toxic dust.

The metabolism of uranium within the living organism has been given due consideration, and the influence of valence state upon the pattern of storage and excretion discussed, especially with regard to the parts played by bone and kidney. One of the significantly important aspects of uranium toxicology was discovered to be the development of resistance to some of the toxic phenomena, and this problem is discussed at some length. Consideration is also given to the biological action of uranium on enzymes and proteins, first, with regard to specific effects upon the kidney tubules, and, secondly, with regard to the mechanism of uranium transport in the blood. Catalasuria is considered in some detail, since it was found to be the most valuable and sensitive test for the early detection of kidney tubule damage by uranium. The relative merits of numerous other kidney function tests in this respect are also outlined throughout the volume. Chapter 15 attempts to place the whole mass of experimental evidence in its correct perspective with regard to the primary mode

of action of uranium compounds on the animal body, and succeeds extremely well in this respect.

The final chapter of Part 1 deals with the problem of human exposure, and discusses in this respect the clinical findings and observation made following a few accidental acute exposures, mainly to uranium hexafluoride. The effects of chronic uranium exposure are also considered with reference to workers in the uranium industry—150 μgm. of uranium per cu.m. of air being the maximum permissible level of air contamination set for industry at the time, and not 50 μgm. as at present applicable in Great Britain. Finally, an outline is given of the extensive studies carried out on individuals employed in various uranium-processing plants. Many may consider the scope of these investigations to be unnecessarily complex.

Part 2 of this work is devoted to a consideration of elemental fluorine and hydrogen fluoride. Inhalational toxicity is considered, and the methods of treatment of the two major types of burns (thermal and chemical) outlined. It was discovered that fluorine produces a burn that is predominantly thermal in character as compared with the peculiar chemical nature of the hydrogen fluoride burn.

The appendix contains details of the large complex organization that went to make up the Manhattan Department of the University of Rochester. An excellent index is included. Any imperfections in manner of presentation, which certainly could be improved upon, can be excused (as mentioned in the volume editor's preface, p. xiii) by reason of the fact that the manuscript was completed to a time schedule by the limited number of personnel remaining after many of the original investigators had returned to other work.

ALAN BUTTERWORTH

THE DIVINING ROD

Psychical Physics

A Scientific Analysis of Dowsing, Radiesthesia and kindred Divining Phenomena. By Prof. S. W. Tromp. Pp. xv+534. (Amsterdam and New York: Elsevier Publishing Co., Ltd.; London: Cleaver-Hume Press, Ltd., 1949.) 60*s*.

THERE are three schools of thought about dowsing: that it is a physical process; that it is a branch of parapsychology (psychical research), diagnosis being made by a process akin to telepathy; and thirdly that it is charlatanry. S. W. Tromp, of Leyden, now professor of geology in the University of Cairo, believes "that these phenomena can be explained by the normal physical and physiological laws". Nevertheless, he calls his 534-page book "Psychical Physics". Chapter 1 deals with electromagnetic and electrostatic fields in living organisms (ranging from Donnan equilibria and brain-rhythms to Gurwitsch's "mitogenetic rays"), in the earth's crust (orthodox geophysics) and in the atmosphere (meteorology). Chapter 2 deals with the influence of electromagnetic and electrostatic fields on living organisms, including reports of their effects on growth of plants and animals, on cancer, and in pain relief. Chapter 3 is mainly concerned with dowsing for water, metals and magnetic fields, with sexing and with diagnosis of disease by pendulum and the like, the emphasis being on magnetic fields and the author's own experiments. Tromp makes no attempt to distinguish sound from unsound work, though he presents a balanced case for Gurwitsch.

Can dowsers substantiate their claims? Tromp by-passes this fundamental question. Recent reviews (by parapsychologists) of literature on dowsing maintain that the verdict cannot be given until more rigid tests have been carried out. In New South Wales the practice of dowsing is widespread; the Water Conservation and Irrigation Commission's records, kept since 1918, show that 84 per cent of bores were successful on undivined sites against 70 per cent on divined sites. I have often asked dowsers: "Do you find a knowledge of geology a useful adjunct?" The answer has always been quite frank: "Very useful indeed"; but the problem of testing the dowsing claim in the field becomes acute. Laboratory tests usually fail, and few dowsers now claim to succeed under laboratory conditions.

In the assessment of their claims, dowsers have had to put up with a good deal of prejudice by men of science. Tromp's book and, in particular, his own experiments will do little to dissipate it. He claims, for example, to have proved that dowsers can detect changes in field-strength of 0·001 oersted. He quotes ten single trials in which a blindfolded student indicated whether he got a reaction while standing near a tangent galvanometer when the ring was either moved from a horizontal to a vertical plane (and vice versa) or not moved at all. The subject scored nine out of ten. Reference to the original paper (*Tijdschrift voor Parapsychologie*, 15, 39; 1947) reveals that Tromp's claim in this book is based on these ten trials alone. Moreover, the 'targets' were not presented in a random order—an elementary rule in all parapsychological 'guessing' experiments.

In the old days the dowser just dowsed, and either found water or did not. Things are more complicated to-day. Tromp needs twenty pages (pp. 340–60) to describe the factors liable to influence or disturb the dowser—conductivity of the soil, human skin potentials, sunlight, cosmic rays, gases and dust in the air, vegetation, atmospheric potential gradient, and numerous others. Since valid evidence for the primary phenomenon is hard to come by, it is pertinent to ask how small differential effects can have been established with certainty.

The book has a valuable list of references. The *Proceedings of the Society for Psychical Research* are confused with the *Proceedings of the National Laboratory of Psychical Research*, and there are many misprints throughout the book.

DENYS PARSONS

PATENTS AND INDUSTRIAL DESIGNS

Patents for Inventions and the Registration of Industrial Designs

By T. A. Blanco White. Pp. lix+389. (London: Stevens and Sons, Ltd., 1950.) 45*s*. net.

Patents and Registered Designs and their Exploitation

By T. A. Blanco White. (This is the Law Series.) Second edition. Pp. ix+79. (London: Stevens and Sons, Ltd., 1950.) 4*s*. net.

IN the first and the larger of these two books, which is the one with which we are here chiefly concerned, Mr. T. A. Blanco White is to be congratulated upon producing such a useful work written around

the Patents Act 1949 and the Registered Designs Act 1949, both of which came into force at the beginning of this year. A text-book upon the law of patents and industrial designs is necessarily addressed to more than one class of reader. Although the bulk of the book is addressed to practitioners, it includes useful material for the novice, and those parts of the text which assume familiarity with the subject as a whole have been conveniently printed in smaller type. However, the novice would perhaps do best to begin with the second book, "Patents and Registered Designs", which is the author's smaller and more popular work and which first appeared in the series of books entitled "This is the Law". It has been rewritten in the light of the amendments arising from the new Acts.

The author has displayed in his larger work not only fine qualities of scholarship, but also a sense of the humanities rarely displayed in text-books of this kind. The spirit in which it is written may reflect in some way the spirit in which the committee, set up in 1944 by the President of the Board of Trade under the chairmanship of Sir Kenneth Swan, tackled the formidable task of reviewing the law and procedure of patents and industrial designs in the light of present-day technical developments and industrial requirements. This committee, which presented three reports (First Interim Report, 1945 (Cmd. No. 6618); Second Interim Report, 1946 (Cmd. No. 6789); and the Final Report, 1947 (Cmd. No. 7206)), recommended a large number of amendments to the existing law, but did not recommend any radical change in the fundamental principles of the British patent system.

When the New Patents and Designs Bill was presented to Parliament, approval was given to the unanimous view of the Swan committee "in favour of the retention of the present (patent) system in this country and this view is supported by witnesses who have appeared before us, representing both inventors and the commercial users of inventions". It is interesting to record that the National Patent Planning Committee of America reported a similar conclusion in 1943 in respect of the American patent system. But if the theory behind the patent system was right, the procedure for carrying it into practical effect needed a drastic overhaul. The new Patents and Designs Acts, while consolidating and codifying the existing law, incorporate substantially all of the amendments proposed by the Swan committee. Practically the whole of the existing provisions of the earlier Acts have been rewritten, and decisions of the courts upon the meaning of the wording of earlier Acts have been incorporated. No such recasting of the form of the law of patents has occurred since the sweeping changes made by the Patents Act of 1883. It is hoped that the main intended benefits of the new Acts to encourage technical development and to cheapen litigation will be effected in practice. With these ends in view, a special judge, the Hon. Mr. Justice G. Lloyd-Jacob, has already been appointed to deal with patent and designs matters in the Chancery Division of the High Court and in the Patents Appeal Tribunal. These many changes in the law have made the task of the author very difficult; but he has wisely adopted the course of reducing to a minimum any reference to the older law or to authorities turning on the wording of earlier statutes. Helpful comparisons of the old and the new Acts together with notes have been included in the tables of the Statutes.

The book commences with an admirable essay upon the British patent system. Eleven further chapters provide a concise exposition of the complicated law of patents and designs: the structure and interpretation of patent specifications; infringement and validity of patents; the practice of the Patent Office, the scope of the activities of which has been increased by the Acts; assignment and devolution of patents and designs, including the new provisions regarding the rights of an employer to inventions made by an employee; registration of industrial designs; licensing of patents and designs, including provisions for preventing abuse of monopolies; Government use of inventions and designs and procedure for obtaining compensation for Crown use. The latter section contains a reference to the work of, and the principles laid down by, the Royal Commission on Awards to Inventors which in 1947 commenced hearing claims in respect of use by or on behalf of the Crown of war-time inventions. The author, in carefully and objectively setting out the many changes in the law effected by the new Acts, has avoided giving his interpretations of many new wordings of the Act, although he has included many penetrating comments. There are no decisions of the court in regard to the new Acts to guide him, but he has endeavoured to place the amendments in perspective in relation to the previous law.

Thus, the grounds of opposition to the grant of a patent have been widened so that for the first time there should be a real prospect of obtaining the refusal of patents that have no substantial chance of being valid. The problem of inventions which should be kept secret on the ground of national security has received close attention, particularly when the invention may be concerned with atomic energy. Wide powers for amending specifications have been given. The law of compulsory licensing has been simplified and extended; but how far the new provisions will be of value to industry or only a source of extensive legal actions remains to be seen. Some of the provisions are complementary to the provisions of the Monopolies Act, which provides for the breaking up of monopolistic arrangements except in so far as they involve United Kingdom patent rights.

There are several important amendments in connexion with infringement of patents. Thus, for the first time, an exclusive licensee can sue for infringement as if he were the owner of the patent. Again, another most important innovation is that infringement proceedings may, if agreed between the parties, be dealt with by the Patent Office. But the Comptroller-General of Patents cannot award more than £1,000 damages unless the parties otherwise agree. As the author points out in a footnote, "The use of this sort of procedure will involve a change in the attitude of patentees towards infringement proceedings. At present most patentees sue mainly for the injunction (which the Comptroller-General of Patents will be unable to grant). But there must be many small patents that would be well worth while suing upon if the patentee could be certain that his costs would not be large compared with £1,000. It remains to be seen what these proceedings before the Comptroller will in fact cost."

These two new Acts are further milestones in the history of the development of the law relating to industrial property, and Mr. Blanco White's two books together should provide very useful guidance to manufacturers and scientific workers as well as legal practitioners.

R. G. LLOYD

Sir Isaac Newton: Theological Manuscripts

Selected and Edited with an Introduction by Dr. H. McLachlan. Pp. vii+147. (Liverpool: University Press of Liverpool, 1950.) 7*s*. 6*d*.

MEMBERS of the general public have not been accustomed to associate Newton with theological controversy, though considerable interest was aroused by a lecture—"Newton, the Man"—prepared by the late Lord Keynes and read by his brother, Mr. Geoffrey Keynes, at the Newton Tercentenary Celebrations held by the Royal Society in 1946. In this lecture attention was directed to the Newton Papers which had been in the custody of Viscount Lymington and which in 1936 were offered for sale. Through the generosity of Lord Keynes, many of these papers ultimately found their way to King's College, Cambridge; ten of the theological manuscripts have been selected and edited by Dr. H. McLachlan in the volume under review.

The value of the book is enhanced by the author's introduction. In the first part are indicated the scope and subsequent history of Newton's writings on religion. These were numerous; according to Prof. Andrade's estimate, "there were over 1,300,000 words in MSS. on theology in the Portsmouth Collection". In the second part of the introduction Dr. McLachlan traces the development and character of Newton's theology, adding a note on Arius and Socinus. This part of the introduction is especially helpful to the layman not familiar with the theological controversies associated with Arianism and Socinianism and which deny the orthodox doctrine of the Trinity. Newton's zeal for Protestantism is evident in his writings on Scripture, Church history and Christian doctrine. Among the manuscripts included in Dr. McLachlan's volume are "Irenicum—or Ecclesiastical Polity tending to Peace", and several on religion. As might be expected from Newton's Unitarian interests, there is a manuscript in which special attention, in the form of "Queries", is directed to the word "homoousios" and the meaning of the Nicene Creed. The longest manuscript concerns the morals and actions of Athanasius and his followers.

General and Scripture indexes are provided; the presentation of these hitherto unpublished MSS. of Newton has been made possible by the Hibbert Trustees.

H. D. ANTHONY

The Yellow Wagtail

By Dr. Stuart Smith. (New Naturalist Monograph.) Pp. xiv+178+12 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1950.) 12*s*. 6*d*. net.

THE yellow wagtail (*Motacilla flava flavissima*) is a sub-species (confined almost entirely to Great Britain) of a species which is widely distributed in the Old World. It was not until 1832 that Gould separated the yellow wagtail from the blue-headed wagtail, which, in its winter quarters, considerably outnumbers the yellow wagtail. As many as twenty sub-species of *Motacilla flava* have been separated. The yellow wagtail is a local bird in Britain; in Scotland the valley of the Clyde is its headquarters. It no longer nests in districts from which it used to be reported; it does not apparently nest in the Hebrides (how many readers will recognize these Western Isles in the author's name "Ebudes"?), although at one time it bred on Raasay. In northern England the bird has increased; but in the south of that country it has generally decreased. It has now entirely disappeared from Eire as a nesting species.

Dr. Stuart Smith has devoted long and arduous research to his subject, and has brought to light much valuable information regarding this small and attractive bird, which is a summer visitor to the British Isles and winters in West Africa, where the allied sub-species, the blue-headed wagtail, also winters. This book has an added interest and value in that it is illustrated, besides by the author's photographs, by twenty-six reproductions of paintings by Edward Bradbury, paintings which combine beauty with accuracy. The work is of the same high standard of production which characterized the earlier books of the New Naturalist series.

SETON GORDON

Genes, Plants and People

Essays on Genetics. By C. D. Darlington and K. Mather. Pp. xxi+187. (London: George Allen and Unwin, Ltd., 1950.) 16*s*. net.

THE title of this book seems to have been chosen with at least one eye on the intelligent general reader who feels that he does not know much about genetics, but hopes that the book will help him to find a trail through a technological jungle in a *terra incognita*. This class of reader will be sadly disappointed, for the book consists of a series of mainly professional essays, the earliest of which was written in 1929 and the latest in 1945. In addition, there is an article on Soviet genetics, with particular reference to the Lysenko affair, reprinted from *The Nineteenth Century and After*.

These essays are not, as the jacket suggests, "scattered in many journals", since twelve out of sixteen are reprinted from *Nature*. Can the reprinting of such a series of essays in an unmodified form be justified? Some of the essays the authors might want to leave alone. They might hold that the last word has been said. But in a discipline which is above all dynamic and not static, it is pretty certain that an essay written last year is likely to be more valuable than one written some years ago.

Serious workers would, however, be well advised to get the book; first, because for them it is a great convenience to have the essays in book form, and secondly, because they are significant milestones in the history of genetics.

S. C. HARLAND

Modern Plastics

By Dr. Harry Barron. Second edition, revised. Pp. xx+779. (London: Chapman and Hall, Ltd., 1949.) 50*s*. net.

ACCORDING to the preface, the object of the author is to present an overall view of the plastics industry to a reader possessing a modest scientific and engineering background. The subject has been described under the main headings of raw materials; thermosetting resins; cellulose plastics; vinyl plastics; other plastics like nylon, casein, etc.; the analysis and testing of plastics. Included in this second edition are details of German practice as obtained from C.I.O.S. and B.I.O.S. reports, and also a chapter on the silicone resins, but there are some omissions, for example, the polytetrafluorethylene plastics.

Technological aspects of the manufacture of plastics are fully described, and the reader is assisted by many good diagrams and illustrations of plant. The style is of a popular character which results in a somewhat superficial treatment of the chemistry of polymers, but there is little doubt that the author has in great measure achieved his object.

THE FUNCTION OF THE UNIVERSITIES

By the Right Hon. Lord LINDSAY OF BIRKER, C.B.E.
University College of North Staffordshire

READERS of *Nature* will have seen accounts of the opening of the new University College in North Staffordshire, the constitution and syllabus of which are very largely experimental. It is one practical result of all this fermentation and discussion about universities which has been going on in recent years, notably in Great Britain and in Germany and in America, and before I try to give any account of this new experiment, I should like to offer some suggestions as to the reasons for this widespread discussion about the function of the university.

The discussion has been going on in one form or another for some time. There was a very remarkable little book published by the Student Christian Movement Press written by Adolf Löwe, as he was then known, called "Universities in Transformation". It was largely an account of the reasons which had led to what was in his opinion the degeneracy of the universities in Germany, and a warning that the same crisis would sooner or later appear in Britain. Since then there have been many other books and discussions, culminating, of course, in Sir Walter Moberly's widely discussed book, "The Crisis in the Universities".

There are some very general reasons explaining this world-wide trouble about the function of the universities. It is due, I think, in great part to two revolutions which have profoundly affected society in all kinds of ways: one I should call the technological revolution, and the other the democratic revolution. The importance of the technological revolution in the development of universities in the past hundred and fifty years is this. Before that time, the vast amount of industrial production done in Britain was the result of customary skills. University education was confined to what used to be called 'the learned professions', professions which could not be carried on without a good deal of book learning and a certain amount of science. Within the past hundred and fifty years, the importance of scientific investigation for industry and production has been steadily increasing. The result of this is that the standard of life in the modern industrial State depends to a large extent upon the standard of its scientific investigations, and the extent to which the results of scientific investigation become available to, and can be understood by, a great mass of the population. Where production is dependent upon customary skill, we learn things as they have been done. There are, of course, new inventions and discoveries, but the main task of society is to see that these acquired skills are not lost, but are handed on. In a society dominated by the spirit of scientific research, on the other hand, men are always considering whether what is accustomed to be done cannot be done better, whether its beliefs and traditions and customs ought not to be revised.

The universities do not now exist only to hand down learning. More and more it is their business to instil into their students a spirit of scientific research, a way of handling problems, the principle of investigation. Their students, of course, are to be taught what is already known and believed; but they are also to be taught to think and discover for themselves. This spirit of thinking for oneself is not now needed only in the learned professions: on the contrary, it is needed throughout industry. The height of a nation's technical achievement depends upon the height of the standard of its scientific teaching, and how widely the spirit of scientific investigation, as I have described it, is spread throughout the population.

It is possible, of course, to use the increasing power of scientific investigation in either of two ways. We may raise the standard of technical knowledge and technical invention and discovery in a few, and depress the standard of craft in the many. This is an only too possible but an evil way of using the new power of science. Or we may try to bring it about that the spirit of scientific research may spread in various degrees throughout the whole nation. We shall have to replace craftsmanship with the spirit of scientific research.

This all means that our technical efficiency and progress as a nation depend, as they have never done before, on the scientific standards of our universities and upon their accepting the very usual, and I think proper, conception that a university student is to be taught to think for himself. He needs to be able to originate and invent and discover. It also means that somehow there must be close links between the university and the great mass of the population. We are to become a nation of specialists, and yet we must somehow overcome the comparative isolation in which a specialist has to be by reason of his specialization. For this has all to be connected with the democratic revolution, and the democratic revolution repudiates the notion that power shall be confined to a small and privileged ruling class.

In the nineteenth century the ruling class in Great Britain were mostly educated in the ancient universities, and their needs produced a very interesting general education—the Arts Honours Schools—of which the most famous was Oxford Greats. That was at one time thought to be the ideal education not only for politics and the Civil Service, but also for such professions as the Church and the Bar. The other Arts Schools, both at Oxford and Cambridge, fulfilled more or less the same purposes. But this has meant that the politician and the Civil servant have received an education in which there has been little science, and there is an increasing demand in many quarters that politicians and Civil servants should know more of science. On the other hand, science has become so specialized that most of those who have done an Honours Science School know nothing of politics, and have been taught very little of the nature of government and of the system of values on which our civilization depends.

One solution, of course, of this difficulty is that which was taken by Hitler, that we should train men for government with the sort of general education which has been evolved in Great Britain, but with more emphasis perhaps on political institutions, and use other institutions to produce the technical expert. The technical expert in this plan is not supposed to know anything about politics because he is not supposed to take any part in government: he is just a very skilful instrument to carry out the purposes of the specialist ruling class. That is not a solution which could possibly be accepted by people in Britain, and clearly, if we accept the need for the scientific specialist and for technical skill of the highest grade, we must somehow combine that with general education which

will give all students some understanding of cultural values and of politics. I think that if we are to be both an efficient and a democratic nation, that is absolutely essential.

Of course, the understanding of cultural values, politics and economics, which the student whose speciality is science requires, cannot be very profound; but it is not unreasonable to hope that all such men who come out of British universities should have some general understanding of our culture and institutions as well as some special and expert scientific knowledge.

It is interesting that the institutions which seem to me to have grasped and to some extent grappled with this problem are the technical universities of Europe and the great technical institutions like the Massachusetts Institute of Technology and the California Institute of Technology. When I was in Germany two years ago, I found that all the great technical universities of Germany that we saw were demanding that they should have what is called in Germany a "Philosophical Faculty", and that every student in his first two years should take courses in that faculty whatever his technical pursuit was going to be. Both the American Institutes insist that all their students do what we should call Arts subjects as well as technical ones.

We in Great Britain have suffered from specialization as much as anyone else, if not more, especially in the separation between students of science and students of the humanities. Various attempts have been made recently at many of our universities to correct this extreme specialization; but in my view the disease is much more desperate than such mild remedies can deal with.

Two things I think are needed:

(1) Technical universities on the lines of the Massachusetts Institute of Technology and the Technical College of Zurich, which would insist upon some arts or social studies training for everybody.

(2) A widened B.A. degree for all students who hope to be teachers, to go into the Civil Service, or politics, or some social service or business career, which would ensure that men who had a training for these special jobs in society have a training both in science and in arts.

Our experiment in the new University College of North Staffordshire is meant to deal with this second proposal, and I may be able to explain how we are trying to do this on another occasion.

THE CAMEROONS TRUST TERRITORY*

WHEN the major part of the former German Cameroons became a French mandate after the First World War, a small strip where the ties of the populations were with their neighbours in Nigeria was allocated to Britain as Mandatory Power. This is now administered as a Trust Territory. It consists of two sections with a gap of some thirty miles between them. Each is administered as a part of the contiguous region of Nigeria. Although the Trusteeship Council has complained that this arrangement, which is in full accord with the provisions of the trusteeship agreement, hampers it in its task of supervision, it is the only practicable method for such small areas, and the integration of populations in the Cameroons into native authority units across the Nigerian border represents exactly that re-uniting of divided peoples which the original division of the territory was intended to achieve.

To the student of administration this integration has some fortunate practical consequences. The administering authorities of Trust Territories are required to present their reports to the Council in the form of replies to an exhaustive questionnaire. This covers certain topics which the reader of the usual Colonial annual report is expected either to know already or to take for granted—notably the legislative basis and historical background of the present position with regard to such matters as taxation and the administration of justice. On these subjects anyone interested in Nigeria as a whole can find an admirably full statement in the Cameroons report. Again, the plan illustrating the administrative structure of the territory applies equally to the northern and eastern regions of Nigeria. The section on education includes the curricula for all types of schools, and a full account of the new Education Ordinance, with special detail on the provision for grants-in-aid. The section on international relations gives the final resolutions of the African Regional Scientific Conference at Johannesburg and the Jos Land Utilization Conference, and a summary of the findings of that on indigenous rural economy, also held at Jos. There is also a valuable summary of the conclusions of the Colonial Office mission on the mechanization of agriculture. The Native Authority estimates published in the appendix, though confined to the Native Treasuries situated in the Trust Territories or belonging to units in which Cameroons natives are incorporated, are valuable as illustrative material for the study of the native administration system throughout Nigeria.

The Trust Territory itself has one feature which makes it unique in British West Africa, namely, the presence of extensive areas of land cultivated on the plantation system. The land in question was originally alienated under German rule. The plantations were auctioned after the First World War as part of the liquidation of ex-enemy property; the greater number were repurchased by their former holders. In 1946 they were bought by the Nigerian Government from the Custodian of Enemy Property to be "held and administered for the use and common benefit of the inhabitants of the Territory". They were leased to the Cameroons Development Corporation, a body created to manage them. All the profits are "applied for the benefit of the inhabitants of the Trust Territory in such manner as the Governor may determine". The Corporation's second annual report is included among the appendixes to this volume. It employs on its forty-nine plantations a labour force of about 18,000, with a staff of 74 Europeans and 368 Africans. It has its own medical staff, three hospitals and a training school for nurses, and pays the cost of buildings and equipment for schools to be managed by missions or the local Native Administration.

In the Victoria Division, where these plantations are situated, the land in native occupation consists of 'reserves' marked off around the villages. The inhabitants have petitioned the Trusteeship Council with a complaint that these are inadequate. After an investigation, the findings of which are published as an appendix, it has been agreed that an area of 25,000 acres should be released from the plantations

* Colonial Office. Report by H.M. Government in the United Kingdom of Great Britain and Northern Ireland to the General Assembly of the United Nations on the Administration of the Cameroons under United Kingdom Trusteeship for the Year 1949. (Colonial No. 262.) Pp. xvi+384+8 plates. (London: H.M. Stationery Office, 1950.) 10s. 6d. net.

and be offered in 15-acre plots on controlled-tenancy terms, with technical assistance, a guaranteed market for approved crops and social welfare services provided by the Corporation. As the acute population pressure is due partly to immigration—in 1948 there were 9,515 immigrants among an indigenous population of 15,000—this will have to be controlled in future. The investigating officer insists that "what is required is nothing less than a full campaign of community development concerted between the peoples themselves, the Administration and the Cameroons Development Corporation, aiming at the social regeneration of the clan and the spreading of a new interest in agricultural advance, coupled with the development of an aptitude for good husbandry". He makes various recommendations to this end.

The report contains a number of extracts from reports of the Trusteeship Council and the visiting mission which went to the Cameroons in November 1949; this consisted of an Iraqi, a Belgian, a Mexican and an American. It is interesting to compare the comments of the two bodies. The latter shows a genuine appreciation of the practical position, and even urge an increase for the present in the staff of "European administrators and technical officers available to perform the functions of advisers and teachers". In its view, shortage of staff is a limiting factor on the pace of advance towards self-government. It also singles out for commendation the wide freedom of speech allowed in the Territory.

The usefulness of the report for reference would be increased if the numbers of pages as well as paragraphs were given in the index.

L. P. MAIR

DIRECTION OF ARRIVAL OF IONOSPHERIC RADIO WAVES

By W. ROSS
National Physical Laboratory

Early Experiments on Medium Wave-lengths

AMONG the earliest attempts to measure *directly* the direction of arrival, in either the vertical or horizontal plane, of radio waves reflected at the ionosphere were those made about the year 1925 by Appleton and Barnett[1], and by Smith-Rose and Barfield[2]. Of the methods used by these workers, the most important was possibly that in which the angle of incidence in the vertical plane was inferred from a comparison of the intensities of the signals induced by the down-coming waves in a vertical open aerial, and in a vertical loop aerial oriented in the assumed plane of propagation. The mean angle of incidence so measured agreed well with that deduced from the theory of symmetrical reflexion at a postulated reflecting layer some 100 km. high. This was for medium-wave broadcasting stations. Large variations (of the order of $\pm 15°$) in the apparent angle of incidence were observed, and these gave rise to some speculations. The investigators were aware that, if the assumption that propagation was confined to the vertical plane between the transmitter and the receiver was not true, the values of angle of incidence deduced from the loop and aerial comparisons would be in error, and indeed Smith-Rose and Barfield carried out experiments with Adcock-type direction-finders which tended to show that if any lateral deviation did exist it did not exceed a degree or two in magnitude. They appear, however, to have overlooked the point that a small amount of lateral deviation combined with a rotation of the plane of polarization can give rise to very large spurious variations in apparent angle of incidence in the simple loop and aerial method of measuring angle of incidence.

Two years later, Appleton and Ratcliffe[3], and Smith-Rose and Barfield[4], still using the same method, recorded further measurements of angle of incidence. Appleton and Ratcliffe commented particularly on the large and very rapid fluctuations in apparent vertical angle, and concluded that these did not represent true variations in height of reflexion but were due rather to reflexions at different points in a layer of constant height, that is, diffractive reflexion. This appears to be the first mention in the literature of the effects on apparent direction of arrival which could be caused by ionospheric irregularities or roughness. The authors referred to the possibility thus introduced of lateral deviation of the waves from the great-circle plane, but do not appear to have considered in detail how such lateral deviation would affect the apparent magnitude of the changes in angle of incidence which they observed. As will be seen from later references, it is now almost certain that, while the explanation which they offered of 'angle-flicker' is correct, its true magnitude was not so great as they observed and, in fact, their measurements were in error because the assumption implicit in the single-loop and vertical-aerial method that there is no lateral deviation of the waves is not in fact true.

Some time later, Cherry and Martyn[5], working in Australia, carried out experiments similar to those described above, and again observed the large and rapid apparent 'angle-flicker'. They concluded that Appleton and Ratcliffe's explanation in terms of reflexion from different centres of reflexion in the same horizontal plane would require such large variations in equivalent path-length to account for the apparent angle changes observed as to make this explanation unlikely. They favoured interference between waves reflected at layers at different heights (*E*- and *F*-layers). They were not then aware of the large errors due to lateral deviation which have been referred to already.

The matter was very much clarified in 1935 by Martyn and Green[6], who showed that if lateral deviation of the waves occurred along with rotation of the plane of polarization, deductions made from comparison of a single loop and aerial were liable to large errors. Using two loops at right angles along with a vertical aerial, they were able to measure both the azimuth and angle of incidence of the received waves. They were able to show that the real variations in angle of incidence of an *E*- or *F*-layer echo, for example, were of the order of $\pm$ 1–2° instead of the $\pm$ 20–30° obtained from a single loop and aerial. They concluded that the *large* 'angle-flicker' noted by Appleton and Barnett and subsequent workers was not a real effect. Some variation in angle of incidence did occur, but it was much smaller than the early workers had believed they had observed. Martyn and Green, however, by measuring both lateral deviation and angle of incidence, showed that the explanation offered by Appleton and Ratcliffe in 1927 was correct, though based at the time on spuriously large angular variations.

A little before this paper by Martyn and Green appeared, Ratcliffe and Pawsey[7] had published the results of other investigations which, using, in part,

different methods from those described above, had appeared to confirm the earlier conclusions about lateral deviation. By comparing the fading on similar aerials at various separations, they concluded that "when the separation is of the order of one wave-length . . . signal variations are largely uncorrelated". This was on medium wave-lengths (250–350 m. approximately). Their paper does not say precisely what "largely uncorrelated" means, and the records which they included by way of illustration suggest that there is certainly partial correlation at one wave-length. However, on the basis of the above statement, the authors concluded that deviations of angle of incidence up to 25° must commonly occur. Using what was in effect a single Adcock aerial pair, they also made measurements of lateral deviation. They were aware of the effects of polarization errors in this type of measurement, but some of the tests which they applied to demonstrate the absence of such errors (for example, by short-circuiting the aerials) are invalid. It would now be admitted that, for the comparatively small angle of incidence to the vertical which was involved (25°), polarization errors were probably substantial. The fact that close correlation was obtained between the indications on the lateral deviation receiver and the intensity variations of the down-coming ray neither proves nor disproves that true lateral deviation was being observed.

Extension to Shorter Wave-lengths

All the work to which reference has so far been made applied to medium wave-lengths in the range 200–500 m. approximately and mostly to *E*-layer reflexions, though Martyn and Green[6] included some results for *F*-layer reflexions showing that, on 200 m., *E*- and *F*-layer reflexions behaved similarly as regards angular deviations.

In 1935, T. L. Eckersley[8] published a paper describing the results of investigations on shorter wave-lengths (30–40 m. approximately) and largely referring to *F*-layer reflexions. Using apparatus capable of high precision, he showed that the rays reflected at the normal *E*- and *F*-layers possess a small angular spread of one or two degrees. He was chiefly concerned with the rapid, that is, second to second, fluctuations, and was of the opinion that these were all due to one cause, namely, scattering centres in the *E*-layer. Although some of the results quoted appear to show evidence of slower angular changes, that is, variations having periods of a few minutes or even longer, he did not direct attention to this and may not have been aware of their significance. In passing, it may be mentioned that one example quoted by Martyn and Green (ref. 6, Fig. 6*B*) also gives some indication of a rather slower angular change superimposed on more rapid fluctuations. A later paper, also by Eckersley[9], extended somewhat the information contained in his earlier papers. Again the results were intended to apply to rapidly varying angular deviations.

In 1938, Barfield and Ross[10] described the results of direction-finding measurements made with an accurate spaced-loop system. In this paper, for the first time apparently, a distinction was drawn between rapid (that is, second to second) and slow (that is, minute to minute or longer) variations. The authors clearly showed that, for nearby stations and using pulsed signals, there were, in addition to the rapid changes in direction, very much slower changes with periods ranging up to 10 or 20 minutes or more. They ascribed the latter to slowly varying ionospheric tilts. The results quoted apply solely to *F*-region reflexions on frequencies between about 4 and 10 Mc./s.

In practically all the earlier papers, lateral deviation had been thought of as a rapidly varying phenomenon ('angle-flicker'), and after the paper by Appleton and Ratcliffe[3] it had been ascribed to the results of ionospheric 'roughness', that is, to effects of wave interference within a cone of rays constituting a single 'ray'. The paper by Barfield and Ross[10], however, may be considered to have established the existence of much more persistent, though still more or less random, angular deviations due to large-scale and rather slowly varying ionospheric irregularities.

Indirect Evidence of Ionospheric Tilts

At this point, reference must be made to a paper by Pierce and Mimno[11] which does not appear to have attracted the attention which it merits in connexion with the deviations experienced by ionospheric reflexions. They described results which can be observed at vertical incidence and which appeared to show the existence of very long 'wave-length' variations of ionospheric density or height of quite small magnitude. For example, typical results could be explained on the assumption of a variation of ionospheric height (*F*-layer) of $\pm$ 2 km. with a 'wave-length' (that is, distance between points of maximum or minimum height) of about 200 km. These very long wave-length disturbances were shown to travel with a speed of about 600–800 km./hr., which is stated to be about the velocity of sound at these levels. It was therefore tentatively suggested that they were hydrodynamical compression waves in the atmosphere at the *F*-layer height.

It is to be noted that such variations as were suggested, namely, $\pm$ 2 km. height with a 'wave-length' of 200 km., give a maximum effective slope of the layer at any point of 4°; and this, together with the rate at which the disturbances travel, appears to show that they are, in fact, the "slowly varying tilts" of the layer described by Barfield and Ross[10].

In 1941 there appeared the summary of a paper by Eckersley and Farmer[12], of which the full text was not published until 1945, owing to war-time restrictions. This paper, which was again concerned principally with rapid changes, confirmed and extended Eckersley's earlier results[8,9]. Slowly varying changes were not explicitly referred to, but it is clear from certain results that are given that they were present.

Recent Measurements of Ionospheric Tilts

In the meantime, the lateral deviation of high-frequency waves was being continuously studied at the Radio Research Station, Slough, and the evidence supporting the existence of both rapid and slow variations had accumulated. For *F*-layer reflexions at frequencies above about 3 or 4 Mc./s., it is now quite clear that the two types of variation arise from what have to be regarded as different causes. The rapid fluctuations are apparently due to wave interference effects resulting from the 'spreading' of the ionospherically reflected wave into a cone of radiation, this being due to 'roughness' of the reflecting layer on a comparatively small scale. The slower variations have to be pictured as

being due to movement of the whole cone of radiation under the influence of some very long wavelength ionospheric irregularities. The layer at any point can be considered to be subject to a continuously varying degree of tilt, the period of variation ranging from a few minutes up to half an hour or more. The results of these studies carried out over a period of some ten years were recently published in a special report[13]. The standard deviation of the slowly varying ionospheric tilt has been shown to be of the order of 1½–2° under normal conditions.

The report also contains evidence of the direct measurement of the systematic tilt which must be presumed to exist at special times such as during the sunrise period. This 'sunrise tilt' is also described in an earlier note by Ross and Bramley[14].

Up to this time, the scale of the ionospheric irregularities causing the slow tilts had been the subject of speculation. Pierce and Mimno[11] suggested a 'wave-length' of 200 km. or more, and Ross[13] concluded that the linear dimensions (in the horizontal plane) of the irregularities must be at least of the order of 20–30 km. and may be even larger. In order to provide some direct observations on this point, it was decided to make simultaneous measurements with two direction-finding stations separated by several kilometres. The first published results of such experiments by Ross and Bramley[15] show that striking correlation of bearing changes is obtained with receiving stations 10 km. apart. This work is being continued and extended and is to be described in a future paper. It has been found that with receiving stations 27 km. apart there is extremely close correlation in the slowly varying components of angular deviation, which seems to be direct evidence that the scale of the irregularities is of the order of a hundred kilometres or more as originally suggested by Pierce and Mimno.

Measurements of Tilts by Direct Measurements of Ionospheric Height

It is relevant at this point to refer to recent work by a number of Australian workers who, using vertical incidence ionospheric recorders, have observed certain phenomena which are almost certainly linked up with the 'slowly varying' ionospheric tilts referred to above. Gipps, Gipps and Venton[16] comment on 'split traces' and apparent 'doubling' of ionospheric echoes, which appear to be due to the appearance of bumps and concavities on the *F*-layer. Munro[17–19], in recent communications, also describes irregularities in vertical incidence records. These he suggests are due to "very long wavelength ionospheric disturbances which appear to exhibit both vertical and horizontal progression". He favours an explanation of these effects in terms of a pressure wave, that is, similar to the explanation offered by Pierce and Mimno[11]. Similarities in the disturbances observed at Sydney and Canberra (237 km. apart), together with the time difference between the effects, provide evidence both as to the wave-length of the disturbances and their rate of travel. Although Munro calls the effects "short-period changes", the rate of change corresponds to what Ross has called the "slowly varying ionospheric tilt". To those concerned with high-frequency direction finding, changes with a period of several minutes or more are comparatively slow as contrasted with the moment-to-moment changes also present; but to Munro, thinking no doubt in terms of the usual diurnal and longer-period ionospheric changes, variations with a period even of 20–30 min. are 'short-period' changes.

The magnitude of the tilts corresponding to some of the results described by Munro are substantially larger than the average values given by Barfield, Ross and Bramley. For example, Munro singles out an occasion on which a tilt of up to about 30° occurred. This difference, however, can be explained largely by the fact that the Australian methods of investigation, involving as they do a study of vertical incidence *h'/f* records, are likely to be somewhat insensitive to the smaller effects. Only the exceptionally large effects attract notice, and of these the most striking have been selected for detailed analysis. The methods used by the workers in Great Britain, on the other hand, involving sensitive direction-measuring apparatus, are capable of detecting the smaller irregularities, so that the tendency there has been to describe the average rather than the exceptional cases. In fact, exceptionally large tilts, many times the root-mean-square value, have, at times, been observed. The similarity of periodicities seems to show that both groups of workers are, in fact, observing the same phenomenon.

Martyn[20] has very recently given a theory for the propagation of disturbances in the upper atmosphere which appears to be capable of fitting the experimental results obtained, for example, by Munro. It seems fairly certain that the hydrodynamical theory of these disturbances is correct.

Studies of Fading

The effects of roughness of the ionosphere in causing reflexion to be more of a diffractive process than true specular reflexion have continued to be studied by a number of workers, notably those of the Cambridge school under Ratcliffe[21–26]. A number of important papers on this problem have appeared recently, and these add greatly to the understanding of the rapidly varying effects, that is, fading as normally understood, and the rapid angular changes. In particular, through a study of records of fading it has been possible to arrive at much closer estimates of the angular spread of typical echoes. Average values are of the order of a few degrees for echoes from *E*- and *F*-layers and frequencies in the range 2–5 Mc./s. There is evidence that the angular spread diminishes at higher frequencies, in conformity with the results of Eckersley and of Barfield and Ross.

Furthermore, comparison of the fading experienced at neighbouring points has shown that fading is often predominantly due to an apparent translation of an irregular ionosphere past the observer—referred to as an ionospheric 'wind'. It may be, however, that these 'winds' are but another aspect of the very-long-wave compression waves in the upper atmosphere to which reference has already been made.

Conclusions

So far as irregularities in the propagation of high-frequency waves are concerned, more especially when the *F*-region is concerned, it is now quite clear that there are two phenomena involved. There are the comparatively small-scale irregularities giving rise to fairly rapid fading and angular spread or angular 'flicker' of a few degrees, and the larger-scale irregularities giving rise to very much slower angular changes and perhaps slight, but not marked, slow intensity variations as well.

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OBITUARIES

Dr. G. A. Hankins

DR. GEORGE ALEXANDER HANKINS, director of mechanical engineering research in the Department of Scientific and Industrial Research, died suddenly on November 2 at the age of fifty-five. He was born at Portsmouth on April 25, 1895; on leaving school he entered H.M. Dockyard there as an apprentice engine-fitter. From the Royal Dockyard School, where he obtained a Whitworth Exhibition and a Royal Scholarship, he proceeded to the Imperial College of Science and Technology.

During the First World War, Hankins served for a year in the Royal Garrison Artillery; but in 1916 he returned to Portsmouth Dockyard as an inspector of materials and gun mechanisms. A year later he joined the scientific staff of the Engineering Division at the National Physical Laboratory, and remained there until February 1948, for the last three and a half years as its superintendent. Before relinquishing this post, he had, in May 1947, been appointed first director of mechanical engineering research in the Department of Scientific and Industrial Research. As such it was his task to establish and control a new organization to take over the majority of the Engineering Division's work and to expand it some six times, with an eventual staff of more than six hundred. Under his leadership a firm foundation has been laid, research committees have been set up, staff have been appointed to the key posts and a start has been made on the building of new laboratories at East Kilbride, near Glasgow. Such an undertaking, at the present time, is fraught with difficulties, and it is probable that the energy he put into it contributed to his early death. It is indeed tragic that he did not live to see the fruition of his labours.

In the inter-war period, Hankins was responsible first to the late Sir Thomas Stanton and later to Dr. H. J. Gough for many engineering researches, mainly on strength of materials. His work on hardness testing led to the award in 1928 of the degree of D.Sc.(Eng.) of the University of London. He made valuable contributions to the study of fatigue of metals, particularly the effect of surface conditions on the fatigue resistance of spring steels. In 1935 he was awarded the Crompton Gold Medal of the Institution of Automobile Engineers for his work on deep-drawing. Later, his investigations of the strength of welds had much to do with the application of welding both to steel structures and to pressure vessels.

During the Second World War, Hankins's abilities in the organization of engineering research had full scope in connexion with, among many other projects, flame throwers, gun springs and PLUTO. The achievement in this direction of which he was, justly, proudest was, however, the design and construction of the only large supersonic wind tunnel available to the Allies during the War. His experience was utilized on many committees. In 1944 he succeeded Dr. S. L. Smith as superintendent of the Engineering Division of the National Physical Laboratory, and directed the post-war re-equipping of the Division.

Hankins was a member of the Institutions of Civil and of Mechanical Engineers, and for three years was a member of the Council of the latter. He was invited by the North East Coast Institute of Engineers and Shipbuilders to give the Laing Memorial Lecture in 1943, and by the Institution of Mechanical Engineers to give, with Mr. E. F. Relf, one of the Centenary Lectures in 1947.

D. G. SOPWITH

Sir Ernest Graham-Little

BORN in 1867, the son of Mr. Michael Little, of the Indian Civil Service, and Anna English, of Cape Town, Ernest Gordon Graham-Little was educated at the South African College, taking his B.A. at the University of Cape Town, winning a gold medal and a Porter Scholarship. Then, coming to Britain, he took up a medical career and entered at Guy's Hospital, where he graduated M.B.(Lond.) with honours in 1893, taking his M.D. in the following year. For several months he studied skin diseases in Paris, the subject which ultimately became his life's specialty, though he dallied with general medicine at St. George's Hospital for a time, and became physician to the East London Children's Hospital at Shadwell. In 1902 he succeeded Sir Malcolm Morris as dermatologist to St. Mary's Hospital, having previously won the membership of the Royal College of Physicians, and being elected to the fellowship in 1906. In 1911 he married Miss Helen Kendall, by whom he had a son and a daughter; but both their children were lost in early adult life, the daughter by drowning in 1931 when bathing in a rough sea at Saltdean, and the son on active service in 1942.

Graham-Little in his earlier years did a great deal of work for dermatology, and was a favourite teacher of this subject at St. Mary's, writing numerous papers on this subject, and being elected president of the Dermatological Section of the Royal Society

of Medicine, and also of that Section of the British Medical Association for the year.

He was a close friend of Russell Wells, vice-chancellor of the University of London, and was elected a member of the Senate in 1906, a post he retained until May this year. In 1922 he became president of the University Graduates Association, an honour which no doubt greatly helped him in a keen triangular contest in 1924 to be member of Parliament for the University, which he represented as an Independent Conservative until all university seats were abolished recently. He was most assiduous in his attendance at the House of Commons, and was a frequent contributor to debates involving medical principles, and by letters to the Press, becoming chairman of the Medical Parliamentary Committee in 1943. Retiring from his post of physician for skin diseases at St. Mary's in 1934, he had more time for his political work in the House of Commons. He was largely responsible for the recognition of the West London Hospital by the University as an institution for the admission of women as external students.

Hard fighter as he was in the House and in the University Senate, in pushing for reforms he believed in, yet in private life Graham-Little was kind and always ready to help students with advice, and was a most interesting conversationalist among his friends at dinners or club meetings. Although during the last few years his failing eyesight severely limited his activities in public, yet with the help of his devoted wife he followed the controversies of the day, notably the National Health Act, with the greatest keenness, and his letters in the daily Press were a frequent source of pleasure to his friends and supporters in opposition to ministerial autocracy in the National Health Service.

The large attendance of medical and other friends at the memorial service at St. Peter's, Vere Street, on St. Luke's Day, were surprised and delighted by the charming, short and friendly discourse given from the pulpit, regarding his friend Graham-Little, by the Rev. Scott Lidgett, a 'young' veteran of ninety-six.

WILFRED HARRIS

WE regret to announce the following deaths :

Captain E. B. H. Cunnington, for many years honorary curator of the Wiltshire Archæological Society's Museum at Devizes, aged eighty-nine.

Mr. Percy Good, C.B.E., director of the British Standards Institution since 1942, on December 2, aged seventy.

Prof. J. Share Jones, M.B.E., emeritus professor of veterinary anatomy in the University of Liverpool, on December 2, aged seventy-seven.

Dr. Hans Robert Landolt, who had worked at the Royal Institution, London, and the Department of Colloid Science, Cambridge, on the physical chemistry of muscle proteins, on November 30, aged thirty-two.

Dr. J. A. Murray, F.R.S., during 1915–35 director of the Imperial Cancer Research Fund, on November 20, aged seventy-six.

Brigadier Sir Edward Tandy, formerly surveyor-general of India, on November 30, aged seventy-eight.

NEWS and VIEWS

Yerkes and McDonald Observatories: Prof. B. Strömgren

PROF. BENGT STRÖMGREN, director of the University of Copenhagen Observatory, Denmark, has been appointed a professor of astronomy and chairman of the Department of Astronomy and Astrophysics in the University of Chicago, and director of the Yerkes and McDonald Observatories. As he is to retain for the present the directorship of the Copenhagen Observatory and to spend three months each year in Denmark, it can be seen that he is to carry a heavy load of work, and it is not surprising to learn that he will be resigning next year from the post of general secretary of the International Astronomical Union. But the opportunities opened up to him in his new position were too great and important to be refused. They have been well earned, for Prof. Strömgren's work in astrophysics on the structure of stellar atmospheres, and on interstellar space, has placed him among the world's leaders in this branch of science. For his researches he was recently awarded by the vice-chancellors of the Universities of Denmark the first Augustinus Prize of 50,000 Danish kroner. He will be no stranger when arriving in Chicago, as he has visited the University and its observatories in the past and worked there with Prof. O. Struve. His many friends all over the world welcome the appointment and are confident of the success with which he will carry out its many duties.

International Research Centre for Chemical Microbiology, Rome

THE United Nations World Health Organization, with the consent of the Italian Government, has recognized the Istituto Superiore di Sanità (Higher Institute for Health) in Rome as an International Research Centre for Chemical Microbiology. The Institute, under its director-general, Prof. Domenico Marotta, is one of the largest research centres in Italy, and its laboratories are among the most modern and best-equipped in Europe. The research departments include physics, therapeutic chemistry, biochemistry, malariology and bacteriology, and it also contains the main food and drug control centre of the Italian Government. Recent extensions to the existing buildings of the Institute will be used to house the newly created International Centre for Chemical Microbiology. These extensions contain research laboratories as well as a fermentation pilot plant with fermenters up to a capacity of 18,000 l. and all the processing equipment required for the isolation on an industrial scale of biologically interesting substances, such as antibiotics, enzymes, growth factors, etc. Ample workshop facilities are also provided.

The International Centre for Chemical Microbiology will be under the scientific direction of Prof. E. B. Chain, formerly of the University of Oxford, joint winner of the 1945 Nobel Prize for Medicine for the discovery of the chemotherapeutic effect of penicillin and recently elected first chairman of the newly formed Experts Committee on Antibiotics of the World Health Organization. Prof. Chain has been in Rome for two years organizing and directing a new research department of biochemistry at the Institute. The Centre is built up of a number of different research units, including one for biochemistry and organic chemistry, one for bacteriology and mycology, and one for physical chemistry and

microbiological engineering. The chief two aims of the Centre are: first, to provide facilities for research workers to become acquainted with the different methods of chemical microbiology, by working in one of the research units; and second, to make accessible for scientific investigations substances of microbial origin the isolation of which requires equipment of industrial dimensions not normally available in university laboratories. This Centre will be the forerunner of a number of others which the World Health Organization intends to set up in other parts of the world on a wide basis of co-ordinated research, and for which a number of fellowships are being financed. The realization of this project is an interesting example of the value of the schemes organized by the British Council for British men of science to visit foreign countries. In this case the project was the result of a lecture tour which Prof. Chain undertook in Italy for the British Council in 1947.

Losses from Plant Diseases

THERE is, perhaps, a general reticence about the writing of papers which deal with losses from crop disease, yet, whenever dispassionate surveys are made, much useful information of a practical nature is obtained. Mr. W. C. Moore chose to speak on "The Significance of Plant Diseases in Great Britain" for his presidential address to the Association of Applied Biologists (*Ann. App. Biol.*, **36**, No. 3, 295; 1949). Mr. Moore is head of the Plant Pathology Laboratory of the Ministry of Agriculture, Harpenden, and is therefore in a good position to digest the numerous reports on disease prepared by advisory officers. About a thousand different plant diseases are known in Great Britain, but fortunately only about forty are regarded as of economic importance. Some maladies, such as crown rust of oats, *Puccinia coronata*, white root rot of many plants, *Rosellinia necatrix*, and antirrhinum rust, *Puccinia antirrhini*, are much more serious in southern Britain than in the north. Take-all of cereals, *Ophiobolus graminis*, chocolate spot of beans, *Botrytis* sp., and *Didymella* stem rot of tomato are only severe in certain years. Looking to the future, Mr. Moore considers that gangrene of potato, *Phoma foveata*, leaf blotch of onion, *Heterosporium allii*, alternaria blight of tomato, *A. solani*, and ink disease of iris, *Mystrosporium adustum*, may well become more troublesome than in the past. He has, indeed, shown how *Sclerotium tuliparum*, the cause of grey bulb rot of tulips, has increased in distribution since 1922. The status of many other diseases is discussed, and the paper should lead students of plant pathology to that most important asset for their subject—a sense of proportion in assessing disease damage.

Optical Properties of Solid Thin Films

AN international colloquium on the optical properties of solid thin films was held at Marseilles in April 1949 under the auspices of the Centre National de la Recherche Scientifique (see *Nature*, **163**, 885; 1949), and the full text of the thirty-five papers presented, together with a short foreword by Prof. P. Rouard and a list of those who were invited to participate in the colloquium, is now available and appears in the July issue of the *Journal de Physique et le Radium* (**11**, 305; 1950). The national representatives who were invited were as follows: Dr. B. H. Billings, Mr. N. W. Scott, Prof. J. Strong and Dr. A. F. Turner (United States); Drs. K. M. Greenland, O. S. Heavens and H. Kuhn, and Prof. S. Tolansky (Great Britain); Drs. B. S. Blaise and P. van Alphen (The Netherlands); Dr. L. Ballerini and Prof. F. Scaldone (Italy); Dr. Schaetti (Switzerland); and Prof. A. Vašíček (Czechoslovakia). The papers are grouped together under five headings: theoretical investigations of the optical properties of thin films; the preparation of films, and various techniques; experimental investigations of the optical properties; applications; and bibliography. This last group consists of one paper by P. Cotton and P. Rouard, in which an excellent comprehensive survey is given of the literature on the subject of optical thin films and to which is appended some 250 references. Several of the papers are in English; these have French summaries. The remainder are in French, and the majority have English summaries. It is pleasant to note that each paper commences on a separate page. As Prof. Rouard remarks in his foreword, the work described will be of interest to others besides specialists, and shows clearly that French physicists, in addition to those of other countries, have made and are making important contributions in this important and rapidly growing field.

New Tension Meter for Wires and Threads

THE Saxl Instrument Co., Harvard, Mass., has recently announced the development of a new and improved model of tension meter with a total capacity of 125 grams. This meter has applications not only in the textile field but also in the electrical field, wherever quick tension measurements on wires, filaments, thread, etc., are required. The new model has twice the sensitivity of the old 250-gm. model which is still being manufactured. In addition to instant trigger action and correct dynamical calibration under performance conditions, the meter is equipped with ball-bearings throughout, thus reducing roller friction to negligible dimensions. Special precision pulleys recessed in the trigger mechanism automatically guide the yarn into position, and gentle insertion and release are assured. For sensitive nylons and other fine yarn the first revolution of the dial, giving readings on black figures up to 50 gm., suffices. The remaining part of the range, 50–125 gm., is read from red figures on the second revolution of the dial. Therefore, without special adjustments, the pointer can overtravel and continue to give precise readings even when the tension is above the 50-gm. range.

Technology of a Modern Stone-Age People in New Guinea

THE methods used by prehistoric man to fashion his stone and bone implements have long been an object of speculation. Not all tools are chipped in the same way, and more than one way of shaping bone objects can be observed. While analogies must never be pressed too far, it is always interesting to know how a modern stone-age folk set about similar tasks. This is described in "The Technology of a Modern Stone Age People in New Guinea", by Beatrice Blackwood, a publication of the University of Oxford Pitt Rivers Museum (Occasional Papers on Technology, 3; pp. 60+17 pl.; 1950; 10*s.* 6*d.*). The author has lived many months in New Guinea, and the volume is the result of careful observation on the spot of the various techniques employed. The making of stone-bladed adzes, stone-headed clubs, wooden clubs, bows and arrows, bamboo knives, and bark cloth, and also fire-making are all described

and illustrated. There are not only a number of line drawings in the text, but no less than sixteen full-page half-tone illustrations grouped together at the end. This third occasional paper on technology to be issued by the Pitt Rivers Museum is a very worthy successor of the two which preceded it.

Earthquakes in and around India

THE subject of earthquakes in India and neighbouring countries is reviewed by C. G. Pendse in Vol. 10, No. 129 of "Scientific Notes of the Indian Meteorological Department" (Earthquakes in India and Neighbourhood. Pp. 177–220. (Delhi: Manager of Publications, 1948.) 1.14 rupees; 2*s*. 9*d*.). For the period 1917–34 there were no notable earthquakes on the mainland of India or Ceylon south of latitude 20° N. (which runs just north of Bombay); but this area was almost surrounded by earthquake epicentres. The area of most intense earthquake activity was undoubtedly that stretching north-eastward from approximately Kabul in Afghanistan and including the Pamirs. Persia to the west had frequent earthquakes, and no part of it appears to have been free, though the activity was not quite so intense as in the Pamirs. To the east of the latter, stretching into Tibet, the crustal instability of the earth was approximately the same as it was in Persia. There was quite strong activity along a line a little north of latitude 25° N. from near Dhubri and the Garo Hills eastward through Assam to about longitude 102° E. This line of epicentres was at the junction of the 'Tibetan' seismic area and the well-defined ribbon of earthquake activity which stretched southwards through Burma, through the Bay of Bengal to include the Andaman Islands and on to join the East Indies are at Sumatra. Malaya and southern Siam were practically free from earthquakes. Almost to complete the ring around India were three areas of moderate instability in the Arabian Sea (centre of zone near lat. 13° N., long. 56° E.), the Indian Ocean (lat. 2° N., long. 65° E.) and the Indian Ocean (lat. 2° N., long. 87° E.).

Northern Advisory Council for Further Education

THE third annual report of the Northern Advisory Council for Further Education describes the surveys which have been made of the educational requirements of a number of industries within the region; some of these have led to recommendations for the establishment of new courses at technical institutions. Requests for these surveys have come from many sources, the main one being industry itself; the Council has been encouraged by the number of requests from industries which have only recently begun to appreciate the problem of the technical training of their employees. Among items submitted to the Council by the Academic Board for Technology, Commerce and Art were statements on the problems involved in part-time release of young workers in industry and the release of teachers to industry and commerce. Considering the respective merits of day-release and 'sandwich' courses, the Board submitted that the problem of release was not one that could be solved by the adoption of a uniform system throughout industry, and there was room for experiment with continuous systems of release. Notwithstanding present staffing difficulties the Board recommended that every effort should be made to release suitable teachers for periods in industry and commerce; Durham University Appointments Board and the Federation of British Industries have indicated their willingness to help in making the necessary arrangements with firms. Copies of the report may be obtained from the Secretary, 43 Eldon Place, Barras Bridge, Newcastle upon Tyne, 1.

Scientific Papers Published in the Middle East

THE fifth number of the "List of Scientific Papers published in the Middle East", which covers papers received by the Middle East Science Co-operation Office between October 1, 1949, and March 1, 1950 (No. 5, June; pp. 78; Cairo: Unesco Middle-East Science Co-operation Office, 1950), is not only larger than the earlier numbers but also differs in general outlay. The List is now printed in two columns, so that entries can be cut out and pasted on standard index cards. Titles are now given only under the heading relevant to the main contents of the heading; for other subject headings with which the article deals a reference to this section is inserted. To simplify references, all titles have been numbered consecutively, and an attempt has been made to bring the abbreviations used for the different periodicals into line with those recommended by the International Federation of Standard Institutions. Some doctorate theses have been included, and, as an experiment, abstracts or summaries published with the papers have been reproduced, where they do not exceed 150 words in length. Although the List now covers a number of scientific periodicals not obtainable in the Middle East in 1948–49, no claim is made that the bibliography is yet complete in the sense of covering all work published in the Middle East. Nevertheless, the changes introduced are likely to enhance considerably the value of the List to scientific workers and institutions within and outside the region.

Journal of Atmospheric and Terrestrial Physics

DESPITE the difficulties of finance and printing that nowadays beset scientific publication, Butterworth-Springer, Ltd., Bell Yard, Temple Bar, London, W.C.2, have lately launched a new geophysical periodical, entitled *Journal of Atmospheric and Terrestrial Physics* (1, No. 1; 1950; pp. 64; complete vol. (300–400 pp.); 70*s*.); initially publication will be bi-monthly. The editor-in-chief is Sir Edward Appleton, and there is an editorial advisory board of twenty-four members drawn from twelve countries—as is appropriate to the intended international character of the *Journal*, which will publish papers in English, French or German (the first issue contains two papers in German, each with an abstract in English). The chief interests of the editor and his board include radio physics (seven members), meteorology, including atmospheric electricity (six members), geomagnetism and aurora (five members), solar physics (three members), cosmic rays and general upper-atmospheric physics (three members), oceanography (one member); the almost total lack of editorial representation of subsurface geomechanics and geophysics (apart from geomagnetism) is paralleled in the contents of the first issue, which would be adequately described by the title of the *Journal* with the fourth and fifth words omitted. It would be improper to infer the future composition of the *Journal* from one issue; but, as it is, this issue complements the only pre-existing London geophysical periodical, the *Geophysical Supplement to the Monthly Notices of the Royal Astronomical Society*, which has hitherto given far more space to subsurface terrestrial mechanics and physics than to atmospheric physics.

Abstracts on Agricultural and Horticultural Engineering

A NEW quarterly publication, *Abstracts on Agricultural and Horticultural Engineering*, has been started by the British Society for Research in Agricultural Engineering, and the first number has already appeared, obtainable from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (No. 1, Spring 1950; pp. 61; annual subscription, 16s.). The abstracts are being collected from a wide range of home and overseas publications and are usefully grouped under a variety of subjects. Cross-references are provided for by an index; but some self-evident arrangement, alphabetical or otherwise, of the authors cited under each subject would add to the value of the publication. Lists of the bulletins published by the Institute and appropriate publications issued by H.M. Stationery Office are also available on application to the above address.

The National Museums, Ceylon: Annual Reports for 1948–49

THE administration reports of the director of the National Museums in Ceylon for 1948 and 1949 (Report for 1948, pp. 17+2 plates; Report for 1949, pp. 26+1 plate; Colombo: Government Publications Bureau, 1949–50; 55 cents each) are issued at the same time and bear ample witness to the progressive and stimulating outlook of the director, Mr. P. E. P. Deraniyagala. The usual methods of conservation of museum objects have been maintained throughout the period, and it is interesting to note that collections of live animals have been commenced at each of the provincial museums in Ceylon. In common with other national museums, those of Ceylon are now responsible for various collecting expeditions, notably to India and Africa.

Leeds City Museums: Annual Report for 1949–50

THE annual report of the Leeds City Museums for 1949–50 (pp. 8; Leeds: City Museum, 1950) records extensive new casing and reorganization in the main exhibition gallery. The large mammals—of undoubted interest but restricted purpose—have been reduced in numbers, and with new cases and upright partitions the appearance of the gallery has been completely altered. At one end is a brief introduction to animal life, and such subjects as life on land, in the water and in the air, the pattern of life and life histories are dealt with. Other bays provide a visual picture of the four chief types of country seen in Yorkshire. At the other end of the gallery the history of man is portrayed, local objects being used whenever possible. A systematic series, of both invertebrates and vertebrates, has been arranged on a balcony. At Kirkstall Abbey House the exhibition cases have been removed so as to reveal the full beauty of the medieval architecture in the vaulted room. A display of armour and weapons has been mounted around the walls. Temporary exhibitions of varied character, a school loan service, lunch-hour musical recitals, film shows, winter lectures and weather recording are among the activities of this progressive museum.

Lectures for Junior Science Societies and Clubs

A REPORT on "Science Clubs for Young People" has recently been prepared for the United Nations Educational, Scientific and Cultural Organization. This report has been approved by the Council of the British Association for the Advancement of Science, which wishes to help and encourage existing science clubs, to assist new clubs which may be formed in response to a real demand, and to promote co-operation between kindred groups. The Association of School Natural History Societies already exists to help school and other junior scientific societies concerned with the biological sciences, and many such societies have sought its advice regarding suggestions for suitable speakers. The British Association is prepared to supplement this existing service by suggesting speakers on subjects which are covered by its sections, that is: (A) physics and mathematics, (B) chemistry, (C) geology, (D) zoology, (E) geography, (F) economics, (G) engineering, (H) anthropology and archæology, (I) physiology, (J) psychology, (K) botany, (L) education, and (M) agriculture. Requests for such assistance should be addressed to the secretary of the British Association, Burlington House, London, W.1, with as much advance notice as possible and indicating the subject on which a lecture is desired, the proposed time and place of its delivery, and whether it will be possible to meet the lecturer's out-of-pocket expenses.

"Phosphorylation and Absorption of Sugars in the Rat"

WE regret that, in the communication under this title by Miss M. P. Hele published in *Nature* of November 4, p. 786, the description of the two graphs was omitted. It should read as follows: Effect of sugar concentration upon the rate of sugar phosphorylation. Adenosinetriphosphate concentration 0·033 *M*.

□, Galactose (average of 4 rats); ○, glucose (average of 8 rats); ●, fructose (average of 8 rats); ⊙, mannose (average of 5 rats); ×, xylose (average of 5 rats).

Announcements

THE Harrison Memorial Prize for 1950 of the Chemical Society has been awarded to Dr. Hugh Christopher Longuet-Higgins, lecturer in theoretical chemistry in the University of Manchester. This Prize was founded in 1922 in memory of Colonel Edward Frank Harrison, deputy controller of the Chemical Warfare Department during the First World War. It is awarded to the British chemist, less than thirty years of age, who, in the opinion of the selection committee, has during the previous five years conducted the most meritorious and promising original investigations in chemistry.

A CHRISTMAS lecture for older schoolchildren, entitled "The Electric Current, its Action and Nature", will be given by Dr. W. Wilson, manager of the Development Laboratory, General Electric Co., Ltd., Birmingham, at 3 p.m. on January 2, 1951, and again on January 3, in the Lecture Theatre of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. Applications for admission should be sent to the Secretary of the Institution at the above address.

SCOTTISH Agricultural Industries, Ltd., is setting up in the Edinburgh area a new Central Research Department which will, initially, be engaged mainly on research into problems of phosphatic and other fertilizer manufacture. Dr. Bernard Raistrick, at present assistant director of research with Albright and Wilson, Ltd., has been appointed research manager of this new Department.

BIOLOGICAL ACTION OF 'MUSTARD GAS' COMPOUNDS

Mutagenic Activity of beta-Chloroalkyl Amines and Sulphides

IN attacking the problem of the mechanism of biological action of mustard gases, particularly their mutagenic and anti-carcinogenic effects, we have determined the activity of a series of beta-chloroethyl amines and sulphides containing only one reactive grouping. A study of such types of molecules (I and II) is of particular interest in exploring the relation of chemical structure to biological activity. Some monochloroethyl sulphides show the vesicant property of mustard gases. On the other hand, there are indications that mutagenic and anti-carcinogenic activities may be confined to molecules containing two or more reactive groupings[1-3].

$$R\text{SCH}_2\text{CH}_2\text{Cl} \qquad R_2\text{NCH}_2\text{CH}_2\text{Cl}$$
$$\text{(I)} \qquad\qquad \text{(II)}$$

In the present study, the mutagenic activity[4] of the compounds has been tested using the technique described by Dickey *et al.*[5]. In this method nutritionally deficient mutant strains of *Neurospora crassa* are used. The activity of a substance in causing reversions to the non-deficient state is measured. Results of typical experiments are given in the accompanying table. The 'induced mutation rate'[6] is the number of mutants produced divided by the total number of spores treated. In all cases, the tests were carried out in 10 per cent aqueous acetone, 0·25 *M* in sodium chloride, and 0·1 *M* in borate (*p*H 8). The treatments were made at 25° for 30 min., using three to four million spores per millilitre.

MUTAGENIC ACTIVITY OF MUSTARD-TYPE COMPOUNDS

Compound	Conc. (*M*)	Induced mutation-rate ($\times 10^7$)	
		Adenine-less mutant (70007-38701)	Inositol-less mutant (70007-37401)
None	—	(0·3*)	(0·0)
$ClCH_2CH_2SCH_2CH_2Cl$	0·0002	4	—
	0·0001	3	1
$n\text{-}C_4H_9SCH_2CH_2Cl$	0·0002	64	1
	0·0001	11	—
$C_6H_5CH_2SCH_2CH_2Cl$	0·0002	12	—
$C_6H_5SCH_2CH_2Cl$	0·0002	2	—
$N(CH_2CH_2Cl)_3$	0·0002	2	—
$CH_3N(CH_2CH_2Cl)_2$	0·001	4	2
	0·0005	2	0
$(CH_3CH_2)_2NCH_2CH_2Cl$	0·006	13	0·5

* Average of all control experiments. In no case was the spontaneous mutation-rate greater than $1·0 \times 10^{-7}$.

It will be noted that the response of the two mutant strains is distinctly different. For the adenine-less, colonial double mutant (70007–38701), the monofunctional sulphur mustards were even more active than mustard gas itself. This was true also of the monofunctional nitrogen mustards when the compounds were compared at the concentration giving maximum activity. Toward the inositol-less, colonial double mutant (70007–37401), on the other hand, both the monofunctional and polyfunctional nitrogen and sulphur mustards showed slight activity.

The finding that these monofunctional mustard-type molecules have pronounced mutagenic activity is of importance to the study of the mechanism of production of mutations. It provides a clue to the relation of structure to mutagenic activity, and also a simpler molecular type for chemical studies[6].

One of us (C. M. S.) is greatly indebted to Dr. G. W. Beadle and his staff for the mutant stocks and for the opportunity of carrying out some of these experiments in their laboratories. The study was supported in part by the American Cancer Society, in part by the Rockefeller Foundation, and in part by funds provided for biological and medical research by the State of Washington Initiative Measure No. 171.

CARL M. STEVENS
AUGUSTA MYLROIE

Division of Biology,
California Institute of Technology.
Department of Chemistry,
State College of Washington,
Pullman.

June 7.

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Production of Mutations by Monochloro-'Mustards'

IN 1942 it was noticed[1] that 'mustards' with one reactive chlorine atom are less toxic than those with two, to a degree which cannot be accounted for by the difference in chlorine content. More recently, workers at the Chester Beatty Institute in London, in the course of an extensive comparative study of nitrogen mustards and related compounds, have made the same observations for the tumour-inhibiting and cytotoxic activities of these substances[2-4]. They conclude that the presence of 2-chloroethyl chains is a necessary condition for biological activity in this class of chemicals, and they suggest that chromosome breakage and mutation arise through cross-linkage between protein fibres of the chromosome. It seemed desirable to test this hypothesis by mutation experiments with some monochloro-'mustards'.

The experiments were carried out on *Drosophila melanogaster*, using a standard technique for the scoring of induced sex-linked lethals. Two substances were used: (1) the first hydrolysis product of mustard gas, $ClCH_2.CH_2.S.CH_2.CH_2OH$, referred to as 'semi-*H*', and (2) 'butyl-*H*', $CH_3.CH_2.CH_2.CH_2.S.CH_2.CH_2Cl$. Both these substances had already been used in experiments by Kinsey and Grant[5] on yeast cells, and had been found to resemble mustard gas in the production of an irreversible growth inhibition, not paralleled by the effect on carbohydrate metabolism. Moreover, in experiments by Stevens[6], butyl-*H* had produced reverse mutations in *Neurospora*. We have to thank Mr. J. L. Everett, of the Chester Beatty Institute, for preparing the semi-*H*, Dr. M. Bird of the same Institute for exposing the flies to it, and Prof. C. M. Stevens, of Pullman, Washington, for sending us a sample of butyl-*H*. Semi-*H*, dissolved in arachis oil in a 5 per cent solution, was applied as aerosol, butyl-*H* as vapour in an air-stream which passed through the

container with the flies. The times of exposure chosen were long enough to kill a proportion of the males within a few days after treatment. No controls were taken; but the stock to which the treated males belonged (*OrK*) has been in constant use for mutation work in this laboratory for many years, and consistently yields a frequency of about 0·3 per cent sex-linked lethals per generation.

Semi-H. Two exposures, of 45 and 50 min. respectively, gave a combined frequency of 22 lethals in 1,939 tested *X*-chromosomes. This result, 1·1 per cent lethals, is well outside the range of spontaneous mutability of the stock employed; but as Mr. Everett did not feel sure that his preparation had been free of traces of mustard gas, new experiments were undertaken with butyl-*H*.

Butyl-H. A preliminary experiment indicated an increase in mutation-rate in later broods from exposed males. Therefore the males for the two main experiments were mated to a succession of fresh virgin females every third day, and mutation-rates were recorded separately for each brood. Successive broods represent successively younger germ cells at the time of exposure. The pooled data, subdivided into broods, are presented in the accompanying table.

FREQUENCY OF SEX-LINKED LETHALS IN SUCCESSIVE BROODS FROM MALES TREATED WITH BUTYL-*H* ($CH_2.CH_2.CH_2.CH_2.S.CH_2.CH_2Cl$)

Brood	Days after treatment	No. of chromosomes tested	No. of lethals	Per cent of lethals	No. of semi-lethals	Per cent of lethals plus semi-lethals
1 and 2	1–6	1610	33	2·1	11	2·7
3	6–9	911	30	3·3	9	4·3
4 and 5	9–15	1909	21	1·1	3	1·3

The data prove the mutagenic power of butyl-*H*. The course of mutation frequency with time after treatment is the same as for mustard gas[7,8] with a peak in the third brood, followed by a decline. Another similarity with mustard gas consists in the fact that, of 20 sufficiently analysed semi-lethals, 10 (= 50 per cent) turned out to be gonadic mosaics for a lethal. This suggests a delayed mutagenic effect of butyl-*H*[9].

It thus appears that the possession of two biologically active groups and the capacity to form cross-linkages between protein chains are not indispensable properties of mutagenic molecules. It may still be argued that they are required for the production of chromosome breakage as opposed to gene mutation. This, in fact, has been suggested by McElroy and de la Haba[10] in interpretation of their finding that hydrostatic pressure during or shortly after exposure of *Neurospora* conidia to nitrogen mustard reduces the frequency of induced morphological mutants. Since, however, the authors believe that most of these mutants are connected with gross structural changes of the chromosomes, it seems that their result could also be explained as an effect of increased pressure not on the process of chromosome breakage, but on the subsequent process of reunion which, under conditions restricting movement of broken ends, may lead to restitution rather than re-arrangement. Moreover, chromosome breakage has been produced by a great variety of substances, including many which can scarcely be suspected of cross-linking power (for example, urethane, formaldehyde, pyrogallol). The intended analysis of the lethals which have been produced by butyl-*H* will show whether any of them are connected with re-arrangements: the fact that two of them have a dominant notch effect makes this likely.

C. AUERBACH
H. MOSER

Institute of Animal Genetics,
University, Edinburgh.
Sept. 19.

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Mutagenic Activity of some 'Mustard Gas' Compounds

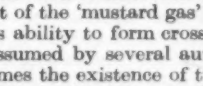
THE problem of the chemical mechanism involved in the mutagenic activity of the 'mustard gases' has been approached by some experiments with monochloro- and dichloro-'nitrogen mustards' which have been carried out in our Laboratories. The mutagenic activity was tested by means of the *Neurospora* back-mutation test[1] with an adenineless colonial double mutant used as a test strain. The data are grouped in the accompanying table.

Compound	1/50 mol. p.c. survived	1/50 mol. mutations	1/50 mol. mut. per 10^6 survived	1/100 mol. p.c. survived	1/100 mol. mutations	1/100 mol. mut. per 10^6 survived	1/200 mol. p.c. survived	1/200 mol. mutations	1/200 mol. mut. per 10^6 survived
1. $CH_3—N^{CH_2—CH_2Cl}_{CH_2—CH_2Cl}$,HCl 'nitrogen mustard'	0	0	0	<0·01	1	400	1	13	22
2. $C_3H_7—N^{CH_2—CH_2Cl}_{CH_3—CH_2Cl}$,HCl *iso*-propyl 'nitrogen mustard'	0	0	0	15	14	5	25	14	3
3. $Cl—CH_2—CH_2—N^{CH_3}_{CH_3}$,HCl *β*-chloro-ethyl-di-methyl-amine,HCl	0	0	0	11	12	17	15	9	10
4. $Cl—CH_2—CH_2—N^{C_2H_5}_{C_2H_5}$,HCl *β*-chloro-ethyl-di-ethyl-amine, HCl	8	63	11	12	25	2	100	0	0
5. $HN^{CH_2—CH_2Cl}_{CH_2—CH_2Cl}$,HCl *bis*-(*β*-chloro-ethyl)-amine, HCl	100	0	0	—	—	—	—	—	—
6. $H_2N—CH^{CH_2—CH_2Cl}_{CH_2—CH_2Cl}$,HCl 1,5-dichloro-3-amino-pentane, HCl	100	0	0	—	—	—	—	—	—

Controls: less than 0·03 mutations per 10^6 spores.

Compound No. 1 is the normal 'nitrogen mustard'. When for the methyl group is substituted an *iso*-propyl group (No. 2) both the mutagenic activity and the toxic effect decrease. The two next compounds are both 'monochloro mustards'. No. 3 has already been found to be mutagenic by Stevens[2]. The mutagenic effect of Nos. 3 and 4, together with the data of Stevens[2] and of Auerbach and Moser[3], shows that the effect of the 'mustard gas' molecule does not depend on its ability to form cross-linkages with the protein, as assumed by several authors[4,5], since this reaction assumes the existence of two active chlorine atoms. This is further supported by the negative results obtained from compounds 5 and 6, both of which should be able to form cross-linkages.

None of these compounds is, however, able to form iminium ions similar to the ion,



which, as already pointed out by Gilman and Philips[6], seems to be the first step in the reaction of the 'nitrogen mustard' molecule. Hence we conclude that it is the ability of the molecule to form the highly reactive iminium ion which is the prerequisite for the biological activity of the 'mustard gas', and that the level of activity determines the level of mutagenicity as well as toxicity, since the larger and therefore less reactive molecules of compounds 2 and 4 are less active than compounds 1 and 3 respectively. As a working hypothesis it still seems most likely that the mutations are induced by the release of energy from the reactions of these very reactive compounds.

K. A. Jensen

Chemical Laboratory,
University of Copenhagen.

Inger Kirk
M. Westergaard

Genetical Institute,
University of Copenhagen.
Sept. 19.

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FRESHWATER BIOLOGICAL ASSOCIATION

OPENING OF WINDERMERE LABORATORY

ON September 23 the Countess of Albemarle, chairman of the Development Commission, formally opened the new laboratory of the Freshwater Biological Association at the Ferry House, Far Sawrey, Ambleside, Westmorland, on the western shore of Windermere. The Ferry House stands on a small promontory projecting from the western shore of Windermere mid-way between the ends of the Lake. The site, of some 2½ acres, is almost surrounded by water. A road past the building to the tip of the promontory leads to a cable-ferry to the Bowness shore 560 yards away. The main building was built of local stone in 1880 as a hotel of some forty bedrooms. Its rooms are of convenient sizes and well provided with windows. On the ground floor are the library, a common room, a large laboratory for the use of classes and visiting scientific workers, a dining-room and domestic offices, a small electrical workshop, and laboratories used by assistants and for the supply of biological material to universities and schools. The first floor contains administrative offices and fourteen rooms fitted as laboratories, mostly of a size suitable for one person but providing bench space for seventeen or eighteen scientific workers altogether. One of these is fitted as a chemical laboratory, and there are also two dark-rooms and a small store-room. The top floor provides living quarters for some members of the staff and also for visitors who come to work in the laboratory. A semi-basement, which opens at ground-level on one side of the building, contains a room into which samples, fish, and collections of all kinds can be brought from boat or car for sorting, cleaning or washing. There also are workshops, stores, a room for algal cultures and one for aquaria. On the other side of the road is a garage and stable block, which provides further storage space and several small rooms on an upper floor. There is at present no boathouse, but it is hoped to build one on the shore of a sheltered bay adjacent to the garages. Besides smaller boats in which outboard motors can be used, the Association has a 36-ft. motor launch with a roomy cabin, from which most of the work on Windermere is done. Row-boats are also kept on certain other lakes, and a smaller craft which can be towed in a trailer behind the large shooting-brake makes it possible to obtain samples from lakes on which there are no boats.

The opening ceremony was attended by some three hundred people, including representatives of the Royal Society, the Ministry of Agriculture and Fisheries, and several of the universities. The president of the Freshwater Biological Association, Mr. Reginald Beddington, in an introductory address, recalled that the foundation of the Association twenty-one years before, in June 1929, resulted from a joint discussion held by Sections D (Zoology) and K (Botany) of the British Association for the Advancement of Science at the Glasgow meeting of 1928. He also referred to the fact that it was on September 23, 1931, that the Association's scientific staff began work at Wray Castle.

Prof. F. E. Fritsch, chairman of the Council of the Association, gave an account of the objects for which the Association was founded and of the work carried on. After referring to the award to the Association of the Einar Naumann Medal at the International Limnological Congress in Zurich in 1948, Prof. Fritsch said: "It is comparatively simple to state our aims in establishing the laboratory, namely, to study the conditions of life of the organisms inhabiting fresh waters and especially those not seriously affected by human interference. We wish to ascertain the composition and distribution of the fauna and flora inhabiting such waters and the factors beneficial to the life within them, so as to provide a better basis for the assessment of the effects of pollution and the study of other problems encountered in the utilization of water and the maintenance of populations of fish. These projects are far-reaching and, as usual in research of any kind, every fresh discovery has opened up new avenues for investigation and widened the horizon to be embraced."

Prof. Fritsch referred to the work of Dr. T. T. Macan in relating the larvæ of insects to their adult stages, of Dr. J. W. G. Lund on the planktonic plants, and of Dr. H. M. Canter on the Chytrid fungi parasitic

on the plankton algæ. He said that one of the main concerns of the Association has been to investigate the conditions determining the productivity of a water, a laborious proceeding since it entails frequent counting of the numbers of certain species together with regular chemical analyses of the water and records of light, temperature and other environmental factors. In this field Dr. C. H. Mortimer and Mr. F. J. H. Mackereth have added to the knowledge of the physical and chemical properties of lakes and have introduced improved methods of investigation. The study of the seasonal changes in the animal and plant life of a lake has revealed their cyclical nature and the importance of the surface layers of the bottom mud as the main site of the processes of decay which result from bacterial action. The Council has recently taken steps to provide for more intensive work on the role of bacteria in fresh-waters. In the investigation of the bottom sediments, the Association is much indebted to Mr. B. M. Jenkin for the design and construction of special apparatus for lifting entire cores to the surface. The study of such cores by Mrs. T. G. Tutin has shown that they are by no means only of geological interest, but may provide a historical background to the studies on productivity. The Council therefore hopes to resume these investigations which have been temporarily allowed to lapse.

Prof. Fritsch referred next to the work of Mr. K. R. Allen, Dr. W. E. Frost and Mr. E. D. Le Cren, all of whom have contributed to the knowledge of the biology of various species of fish. A large-scale ecological experiment begun by Dr. E. B. Worthington, in the course of which about 95 tons of perch and many large pike have been removed from Windermere since 1941, is still in progress, and the effects of this disturbance of the balance of the fish population will only gradually become apparent. Among the significant changes already observed is an increase in the breeding stock of char, which were seen spawning in the River Brathay in 1948 for the first time for forty years.

Hitherto the Association's work on fish has been observational rather than experimental, and concerned more with static than with flowing waters. The acquisition of a lease of Wraymires hatchery and fish-ponds, 2½ miles from the Ferry House, provides opportunities for ecological, physiological and genetical experiments on the problems connected with the growth of fish. Moreover, the Council now feels that sufficient progress has been made with fundamental researches to approach with confidence the more difficult problems of rivers. It is therefore hoped to establish a second smaller laboratory on one of the southern rivers, in order to extend the scope of the research, especially on certain fish, and to make possible the comparison between conditions in the streams of the Lake District and those in a southern chalk stream.

Mr. Beddington then spoke of the help and support the Association has received from the Development Commissioners and from their secretary, Mr. E. H. E. Havelock, and called upon the Countess of Albemarle to declare the new laboratory open. Lady Albemarle paid tribute, for their work on the Association's behalf, to Mr. Beddington, Prof. Fritsch, Prof. W. H. Pearsall, Mr. J. T. Saunders, the second Lord Rothschild, who was the first president, and the late Sir Albert Atkey, who was honorary treasurer for many years. The Association also owes much to its staff, especially Mr. P. Ullyott and Mr. R. S. A. Beauchamp who began the work under Prof. Pearsall's guidance, Dr. E. B. Worthington, the first director, and not least the present director, Mr. H. C. Gilson, on whom has fallen the task of seeing that the Ferry House should be ready that day.

The Development Act of 1909, continued Lady Albemarle, made no reference to freshwater biology, nor indeed to research in connexion with fisheries, though research was specifically mentioned in relation to agriculture. From the first the Commissioners worked to ensure that the resources of science should be brought to bear on the practical problems of fisheries, bearing in mind that they were instructed to promote economic development. Since the Commissioners were also concerned with the general welfare of the countryside, they did not limit themselves to the interests of commercial net fisheries. Nevertheless, they had to consider aid for freshwater fishery research from the economic point of view; and the amount of money which could be made available was therefore limited and had to be related to other claims on the Development Fund.

To advise on the principles which should guide the spending of this money, the Commissioners in 1919 appointed an Advisory Committee on Fishery Research. The chairman was Sir William Hardy, the other scientific members being William Bateson, W. M. Bayliss, G. C. Bourne, H. H. Dale, Walter Garstang, John Graham Kerr, E. W. MacBride and R. E. Scharff; two laymen interested in the immediate problems of deep-sea and inshore fishermen, G. C. L. Howell and Harold Wright, were also members. This committee's report contained the following passages, which although they related to sea fisheries were also relevant to those in fresh water: " . . . nothing less than a complete knowledge of the sea and the life in it, and especially the interdependence between fish problems and *all* the conditions of fish life, will suffice to form a rational basis for fishery development. . . . Another principle governing the organisation of research is that opportunity must be given for the appearance and growth of new ideas. It is impossible at the outset to say what ideas will lead to results of economic importance. . . . The real problem, as the Committee conceive it, is not to distinguish whether this or that class of research, free or economic, pure or applied, is most likely to lead to immediate practical results, but to detect and secure that organisation which shall best promote the development of the fisheries by the increase of the knowledge of all marine life."

For administrative purposes the Advisory Committee adopts a distinction between 'directed' research financed through government departments and 'free' research which is supported in independent laboratories. There is general scientific supervision of programmes and of the quality of the work by the Advisory Committee, but the Commissioners have never attempted the impossible task of determining whether or not a particular part of a programme is likely to have economic value. It is essential that the closest relations should be developed between, on one hand, the growing staffs of the Fisheries Departments and of the Water Pollution Research Board of the Department of Scientific and Industrial Research and, on the other, those whose future base would be the Ferry House. The first necessity is to identify the major practical problems, so that those whose task is to build up basic knowledge of all the aspects of life in river, stream and lake can bear those problems in mind; then their fundamental research will be, in

the words of Sir Edward Appleton, "objective fundamental research". The choice of subjects for 'free' research is difficult and, when freedom is given, the temptation to pursue fascinating by-paths merely for the sake of exploration must be resisted. The Commissioners hope that, by choosing staffs wisely and giving them the accommodation they need, it will be possible to build sound foundations.

In considering priorities after the Second World War in the light of the principles laid down by the original Advisory Committee, the Commissioners have been advised by a special committee of which Sir John Graham Kerr is chairman. This committee discusses with representatives of the Association a memorandum on post-war development prepared by the Council. Its recommendations for the strengthening of both staff and equipment, especially in the fields of algology and bacteriology, have now been implemented to a considerable extent. For accommodation the Association has been exceptionally fortunate in finding the Ferry House, for it would otherwise have been necessary to remain for some five years at Wray Castle and then acquire land on which to build afresh.

MANCHESTER COLLEGE OF TECHNOLOGY

EXTENSION OF THE DEPARTMENT OF MECHANICAL ENGINEERING

AFTER numerous recent discussions of plans for technical education at the higher levels, it may be refreshing to consider the way in which older provision has been developed in an endeavour to meet modern requirements. One such opportunity has been provided by the formal opening by Mr. Louis Mather on December 7 of the first part of the extension to the Manchester Municipal College of Technology, namely, that devoted to mechanical engineering.

The College, which was founded as a Mechanics Institute in 1824, has a double role, first as the major technical college in a wide regional scheme and dealing with subjects at an advanced level (higher national certificates, special and refresher courses, etc.), and secondly as incorporating the Faculty of Technology of the University of Manchester, with which it was integrated in 1903, and working for the Bachelor's, Master's and Doctor's degrees. The happy blending of these two functions, with marked advantages to both sides, is a major feature of the work of the College, and provides opportunities for developments, particularly in connexion with part-time activities.

Though the building completed in 1903 stands as a majestic monument to the courage and wisdom of its founders, provision was made for its growth, and the extension under construction, which will double the original size, forms an integral part of the whole. The section now being opened contains one very large single-storey laboratory, several smaller laboratories and stores, offices for members of the staff, and two drawing offices. Alternative accommodation is also provided for other departments, and will enable the Department of Mechanical Engineering to extend considerably its laboratory facilities in the older building. Though schemes developed since the commencement of construction, delayed by the War, have necessitated changes in the purposes to be served by the various rooms, these have been skilfully adapted, and the general impression is one of fitness and great dignity. The full provision of offices for the staff and of a departmental committee room will not be available for a few months, but the facilities for quiet study and undisturbed consultation, so often overlooked, have received appropriate attention. It will be a little time yet before the full adjustments in the older building are completed, but there is no doubt that the final result will be very good.

Though the arrangements made in 1903 were considered very lavish, it is interesting to note that five laboratories and access to the College power-house were considered adequate to cover the various branches of mechanical engineering exclusive of craft-work, which is now dealt with elsewhere. In contrast, the later developments in engineering science and technology, and the refinements of modern methods, now call for more than four times this provision. For example, the measurement of the fundamental engineering quantities, such as size and form, temperature and heat, quantity, pressure and velocity of flow, which formerly occupied only small sections of general laboratories, now require separate provision and call for a degree of specialized knowledge and skill which, combined with work of a more traditional nature, make the selection and training of staff a far more formidable task than in earlier days. Nor can the requirements of modern industry in respect to such measurements be considered as essentially of a lower order than those for research. There are no separate research laboratories. It is a deliberate policy throughout the Department to bring teaching and research into close relationship so that the student becomes conscious of the refinements which can be made to the relatively simple apparatus which he himself uses, of the skill required in their handling, and of the concentration and care needed in planning, carrying out and completing an experimental investigation. Through the help given in the laboratories to industrialists seeking the advice and assistance of members of the staff, the student becomes aware also of the close relationship of his own task to the needs of the profession he is seeking to follow—a matter which too easily becomes obscured, to his considerable discouragement.

The equipment of the Department can be classed roughly under headings: (1) normal teaching equipment, (2) equipment for precise basic measurement, (3) special-purpose plant for specific investigations; but such a classification is far from satisfactory. For example, the precision measuring equipment may well be required to illustrate the logical development of the apparatus actually handled by the students, as well as being fundamental to research, while the systematic planning of research ensures that, through the medium of the equipment required, it will contribute to the work of the Department as a whole. It is interesting that research projects, though very frequently arising from discussions with the representatives of industry and receiving much help from them, are entirely under the control of the head of the Department, and that, in fact, suggestions for work which might be considered as routine or developmental are scarcely ever made.

The contribution of industry to the equipping of the Department, whether for teaching or research, is remarkable, both for its liberality and for the co-operative spirit in which it is made. It may take the form of raw material, a complete major unit of

plant, or of a large number of items which together form a unified whole. A completely air-conditioned and automatically controlled wind tunnel for heat transfer tests is an example of the latter, sixteen firms having worked together to produce a unique plant of great value.

In addition to generous help from the local education authority, and from the University Grants Committee, the College has profited very greatly from the scheme for the acquisition of surplus government equipment in the development of which it played a leading part, and from loans from government departments.

In a Department which has been almost entirely equipped or re-equipped on a lavish scale within a few years, only a few sections can here receive special mention. The many problems relating to heat claim six laboratories, including extensive provision for the study of heat generation and transmission involving the use of a number of wind tunnels, of refrigeration and of instrumentation. The large new laboratory is devoted to the detailed examination of the various machining processes, to the structural and functional design of machine tools, and to advanced welding methods and the design of welded structures. The laboratory for the examination of the strength of materials contains much excellent equipment and has ample provision for the study of fatigue, and a very wide range of strain-measuring devices. A new laboratory for the study of problems in relation to hydraulic power transmission is being equipped to supplement the more normal work of the Mechanics of Fluids Laboratory. The excellence and range of equipment in the Engineering Metrology Laboratories place them in a unique position to aid in the development of the teaching of the subject up to the highest levels and to serve precise researches in many branches of engineering. Though less spectacular, the work of the Department on the close study of teaching methods in the laboratory and the teaching of machine design is of considerable interest.

The Department of Mechanical Engineering is very happily supported in its work by associated Departments of Electrical Engineering, Metallurgy, Physics, Chemistry and Mathematics, to which it contributes in its turn.

The College can indeed be congratulated on having achieved a unity of purpose by a process involving adaptability and constructive compromise, and for the part which it is playing in the development of the study and teaching of technology in Great Britain.

COMMITTEE ON INDUSTRIAL PRODUCTIVITY

REPORT FOR 1949

THE second report of the Committee on Industrial Productivity*, which covers the activities of the Committee during 1949, is also the final report, for in it the Committee reaches the conclusion that no further purpose would be served by its continuance, as the tasks hitherto entrusted to it can in future be better performed by other existing bodies. In a written statement to Parliament on July 24 the Lord President of the Council announced that the Government had accepted the Committee's own recommendation for its discharge; the Lord President said further that, since the time when the Committee and its panels were set up as a short-term measure to bridge the gap between the winning and application of knowledge in both the natural and the social sciences, the importance of increasing industrial productivity has become generally accepted and productivity is increasing at a most encouraging pace.

The Committee in its report refers to the work of the Anglo-American Council on Productivity which has already sent twenty-four productivity teams, representative of the management-, technical- and workshop-levels in selected sectors of British industry, to visit the corresponding sectors of industry in the United States, and to the action taken by more than twenty trade associations, encouraged by the Engineering Advisory Council of the Ministry of Supply, to work out mutual aid schemes or increase efficiency and reduce costs. The General Council of the Trades Union Congress has decided to establish a productivity department and has asked the British Institute of Management, which is steadily increasing its activities, to prepare a handbook on productivity techniques for workshop representatives, etc.

Besides work on standardization and simplification in industry and the establishment of the National Research Development Corporation in June 1949, good progress has been made in the development of joint consultation and works information in industry, while the Technical Assistance Scheme of the Economic Co-operation Administration has made possible visits to the United States by a number of specialists and technicians from Government departments and research associations to examine particular problems in the United States from the point of view of increasing production and efficiency in Great Britain. Arrangements can also be made for teams of experts from a number of countries to go to the United States to study, for the benefit of European industry as a whole, particular advances in American technology, and the United Kingdom has already participated in several such projects.

Available figures indicate that productivity has been steadily increasing during the past two years, and the Committee on Industrial Productivity regards it as reasonable to assume that the increased production is due chiefly to an increased annual output per worker. It emphasizes that, while the part played by science and technology in promoting productivity is clear and well recognized, but subject for achievement to such conditions as an ample supply of power and of capital for improvement, it is doubtful whether the importance of the human side of the problem is yet sufficiently appreciated. Technical improvements cannot achieve their full effect if the necessary human relations are lacking. The Committee believes that scientific investigation can help the promotion of good human relations, and that it is necessary to develop the social sciences side by side with the physical sciences; the approach to the human aspects of this problem must not be too narrow, but should be based on a study of all relevant parts of social environment. Furthermore, the Committee is of the opinion that it is not always enough, in considering possible improvements in productivity, to examine human factors alone or in isolation; human and technological factors in industry tend to be intermingled or intimately related and to react so

* Second Report of the Committee on Industrial Productivity. (Cmd. 7991.) Pp. 10. (London: H.M. Stationery Office, 1950.) 4d. net.

decisively on each other as to call for a joint consideration of the two aspects.

The Panel on Human Factors in Industry has continued to sponsor the nine research projects mentioned in the first report of the Committee, and in addition has been concerned with the training of field-workers for research into social problems in industry, the effects of compulsory National Service on the training and attitude to work of young industrial workers, and arrangements for ensuring the effective dissemination of information acquired in the course of research into the human aspects of the production problem. Reports on the research projects are expected to be ready in the latter half of this year, and the Committee thinks that their completion should be made the occasion for a full review of the Panel's work. This review, the Committee recommends, should be carried out by the Medical Research Council, and the Government should then consider whether the scheme which that Council is working out with the Department of Scientific and Industrial Research for undertaking wider programmes of work in the field of human factors will adequately cover the national needs in this field.

The statement on July 24 by the Lord President of the Council indicates that appropriate arrangements to this end are being made, and also that the Panel on Imports Substitution is being re-formed to deal with technical aspects of the development of natural resources, whether to save imports or not. The Committee's other recommendation that the work of the Panel on Technology could be adequately provided for by the appropriate production departments and by the Department of Scientific and Industrial Research calls for no specific action, but, as recommended by the Committee on Industrial Productivity, the Advisory Council on Scientific Policy has taken over, as a matter of long-term concern to science and industry, the responsibility for following up the work of the Panel on Technical Information Services (see *Nature*, August 26, p. 323). Here, as generally, the main reason for the termination of the work of the Committee is that the keener and more general interest in the wide range of problems with which it has been concerned has diminished the value of its own contribution, and has made it more important for the main responsibility for studying these problems to be placed on more specialized bodies and on those in day-to-day touch with particular industries.

STOCHASTIC PROCESSES

THREE papers, which have already appeared in the *Journal of the Royal Statistical Society* (Series B (methodological), **11**, No. 2) and which were read at a symposium on stochastic processes held on June 9 last year, have now been published together in one volume*. While in no sense a complete exposition of this thriving field of research, they provide a lucid introduction to three different aspects of the theory, together with important original contributions.

The first and longest paper, by J. E. Moyal, begins with a survey of statistical theories in theoretical physics, which is followed by a long and systematic account of stationary and additive random processes. These two subjects are both well known to specialists in each; but few are acquainted with both, and the main purpose of Moyal's paper is to demonstrate the very great importance which the theory of random processes is beginning to assume in many different branches of physics. This is done in the third part of the paper where the previously developed theory is applied to a variety of subjects such as the theory of quantum-mechanical wave packets, various aspects of the Brownian motion, the shot effect, the theory of noise and the theory of turbulence. The paper concludes with an elaborate and original discussion of the differential equations of motion for the distribution functions of physical processes with applications to classical kinetic theory, the thermodynamics of non-uniform states and quantum theory.

The second paper, by Prof. M. S. Bartlett, is concerned with evolutive processes which are either additive as in the problem of the random walk, or multiplicative as in more complicated situations. Bartlett describes various special additive random processes such as those which occur in the theory of insurance risk and in industrial renewal theory, and unifies his discussion by basing it on Wald's fundamental identity in the theory of sequential analysis. This section concludes with a very pretty application of random walk theory to Kolmogoroff's theory of cumulative sample distribution functions.

Multiplicative and other non-additive processes are described in the second part of Bartlett's paper. These have arisen in a variety of problems, the earliest being that of the probability of extinction of surnames, which was proposed by Galton. Such processes also occur in physics and genetics. Bartlett considers problems of a more complicated type concerned with what he calls "mixed" processes, and discusses, in some detail, the application of such a theory to the epidemiology of measles.

D. G. Kendall's paper is mainly concerned with those multiplicative processes with a continuous time variable which are the natural probabilistic generalizations of the usual deterministic formulation of population growth, but he also gives a very interesting account of the history of the 'surname problem' mentioned above. Kendall gives a lucid account of earlier work on stochastic population models and the related physical problems considered by Furry and Arley. This is followed by an account of some further new contributions of his own. These deal with the problem of the estimation of parameters from an observed process, with the stochastic formulation of the 'problem of the two sexes' which has already been discussed deterministically by Karmel, and lastly with the stochastic fluctuations in the age distribution. Much remains to be done on these problems, especially the last.

Not the least interesting part of this volume is the verbatim report of the discussion which followed the three papers. This included a simple demonstration of the solution of the equations of the simple type of 'birth and death' process by N. Arley, discussions of the application of stochastic processes to the mutation of bacteria by Coulson and Armitage, and further original contributions by Good, Prendiville and Le Couteur. The most impressive feature of the whole symposium is the very wide range of application of these theories, and it is clear that every person interested in the application of mathematics to other sciences should read this volume carefully.

P. A. MORAN

* Symposium on Stochastic Processes (Contributions by J. E. Moyal, M. S. Bartlett and D. G. Kendall, and a verbatim report of the subsequent discussion). Pp. 132. (London: Royal Statistical Society, 1949.) 12*s.* 6*d.* net.

LETTERS TO THE EDITORS

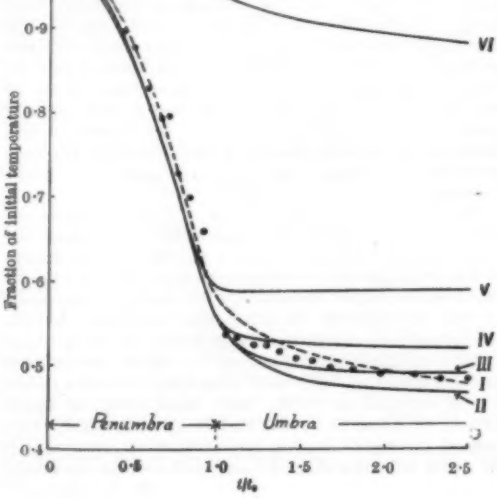
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nature of the Surface of the Moon

THE question of the nature and temperature of the lunar surface has recently acquired a new interest since microwave radar observations of the temperature have become possible. Twenty years ago Pettit, working in the infra-red, measured the fall of surface temperature during a lunar eclipse, and from this information Epstein[1] deduced that most of the surface is covered with a material the thermal properties of which are comparable with those of pumice. If K, ρ and c are the thermal conductivity, density and specific heat of the lunar material (assumed to be constant), t_0 is the duration of penumbra, and A is the insolation before the eclipse, he gave the formula

$$\frac{4At^{3/2}}{3t_0(\pi K\rho c)^{1/2}}. \qquad (1)$$

for the fall of temperature up to time t after the beginning of penumbra, and from the observations deduced $(K\rho c)^{-1/2} = 120$, the units being c.g.s. and ° C. The source of this formula was not stated, but it is, in fact, that for the surface temperature of a semi-infinite solid from which heat is extracted at the rate At/t_0 per unit time per unit area. This is equivalent to assuming that the surface loses heat during the eclipse at a rate proportional to the fourth power of its initial temperature, instead of to the fourth power of its actual temperature, and since the temperature-range involved is from 370° K. to about 200° K., formula (1) will give values which are far too large. To get an accurate result, the non-linear equations must be studied numerically: this has been done recently by Wesselink[2], who finds a value $(K\rho c)^{-1/2} = 920$, and shows that this value is consistent with dust at low pressures (he does not point out the incorrectness of Epstein's calculation, and, indeed, states that their results agree, which by a coincidence they do, though, in fact, they are in different units).



We made similar calculations in connexion with the microwave observations of Piddington and Minnett[3], but have taken the matter a good deal further. In the accompanying graph, the dots show Pettit's[4] observations of the 1939 eclipse, while curve I is calculated for a solid with $(K\rho c)^{-1/2} = 1{,}030$: the main discrepancy between the two is the fact that the experimental curves fall much more slowly than the calculated ones in the umbral phase. This discrepancy is not removed by changing the value of $(K\rho c)^{-1/2}$, which simply moves the later parts of the curves up or down. Two possible explanations may be suggested: (i) that it is an effect of the variation of thermal conductivity with temperature; or (ii) that the solid is not homogeneous. With regard to (i), we can only say that we have not been able to reproduce the experimental curves with likely laws of variation of conductivity with temperature. With regard to (ii), however, it has been shown[2] that the microwave results cannot be explained on the assumption of a homogeneous solid, but that a good fit is obtained by assuming that a thin skin, of conductivity K and thickness d, lies on a substratum with thermal constants K', ρ', c', provided that the quantities are related by

$$d = 610\,K(K'\rho'c')^{-1/2}. \qquad (2)$$

Assuming this surface layer to be dust with $K = 2{\cdot}8 \times 10^{-4}$ (which with the reasonable values $c = 0{\cdot}2$, $\rho = 1{\cdot}7$ corresponds to the $(K\rho c)^{-1/2} = 1{,}030$ of curve I), we have repeated the eclipse calculation for various values of d and $(K'\rho'c')^{1/2}$ satisfying (2). Curves II, III, IV and V of the figure are for the values 0·24, 0·17, 0·12, 0·05 of d with the corresponding values of 140, 100, 70, 30 of $(K'\rho'c')^{-1/2}$. Since curve III gives the best fit, we conclude that the surface behaves like a layer of about 2 mm. of dust on a substratum for which $(K'\rho'c')^{-1/2}$ is about 100. This value corresponds to the terrestrial values for substances such as pumice or gravel and suggests that the surface consists of granular matter interspersed with dust which lies on top of it to a depth of about two millimetres.

Finally, it should be remarked that the observed temperature is an average over a small region of the surface, and that it is possible that portion of the region may be covered with bare rock and the remainder with dust. Curve VI shows the corresponding result for bare rock, $(K\rho c)^{-1/2} = 20$, and by combining this with the others it appears that it is unlikely that more than 5 per cent of the surface is bare rock.

J. C. JAEGER

University of Tasmania.

A. F. A. HARPER

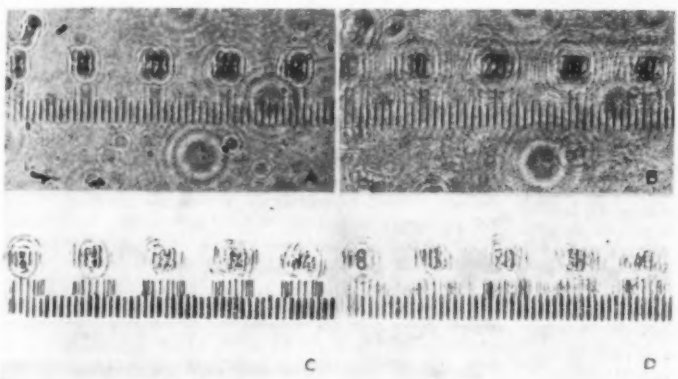
National Standards Laboratory,
Sydney.
Aug. 14.

[1] Epstein, P., *Phys. Rev.*, **33**, 269 (1929).
[2] Wesselink, A. J., *Bull. Astro. Inst. Netherlands*, **10**, 351 (1948).
[3] Piddington, J. H., and Minnett, H. C., *Aust. J. Sci. Res.*, **2**, 63 (1949).
[4] Pettit, E., *Astrophys. J.*, **91**, 408 (1940).

The Black and White Hologram

It has been shown[1] that there exists an analogy between a Gabor diffraction 'hologram' and a zone plate. This idea led immediately to the following experiment, which has been successfully carried out.

A bromide enlargement from a hologram (*A*) (part only is reproduced) was taken and all the important lines (as judged by the operator) were inked in with indian ink using a mapping pen. Attention was confined, so far as possible, to the fringes produced by the object (a micrometer eyepiece scale), those due to extraneous dirt being omitted. The silver image was next removed from the print with a Farmer reducer, leaving a black-and-white representation of the hologram (*C*). A transparency was then made from this for use in the reconstruction apparatus.



(*B*) shows a direct reconstruction from the original hologram (*A*) using the technique previously described without any intervening auxiliary lens. It is, in fact, a particular Fresnel diffraction pattern of *A*. (*D*) is a similar reconstruction from (*C*). It will be seen at once that (*B*) bears a close resemblance to the original microscope scale, as anticipated, and (*D*) bears a more distant but still recognizable relationship.

In comparing (*D*) with (*B*) the following differences between (*A*) and (*C*) should be borne in mind. (1) We have replaced a continuous-tone photographic representation by an abruptly changing black-and-white line drawing. (2) Owing to the difficulty of drawing the outer fringes (which are very fine) the system has in general been terminated at the third or fourth fringe. (3) Small errors in placing the lines on the fringes are, humanly speaking, impossible to avoid, especially where the 'wanted' fringes are partially obscured by 'unwanted' fringes.

In view of the first of these changes, search was made for possible 'high-order' images, as suggested in the previous communication. None was found.

Practical and theoretical work is at present in hand to ascertain whether the possession of a harmonic series of focal lengths is a special property of linear and circular zone plates of definite symmetry, or whether it may be expected in holograms in general.

G. L. Rogers

Carnegie Laboratory of Physics,
University College,
Dundee. July 26.

[1] Rogers, G. L. [*Nature*, **166**, 237 (1950)].

Internal Pair Creation in Magnesium-24

The theory of quantum electrodynamics predicts the occasional emission of an electron-positron pair from an excited nucleus in place of a hard γ-ray. The probability of this event, or the 'pair conversion coefficient', has been calculated by Rose[1]. It is dependent on the quantum energy and on the multipole character of the nuclear transition.

We have examined the simultaneous emission of three particles (a decay β-ray and an electron-positron pair) from a sodium-24 source and made a measurement of the pair conversion coefficient for the 2·78-MeV. γ-line. Internal pair creation in such a source could be due to either of the two γ-rays of magnesium-24, but the probability for the 1·38-MeV. line would be very small as compared with that for the 2·78-MeV. line.

Three Geiger counters (20th Century Electronic *B*6 type) were arranged symmetrically around a sodium-24 source, and the number of triple coincidences was determined. When corrections for random coincidences were made, the remaining triple counts exceeded those attributable to $\beta\gamma\gamma$-coincidences by a factor of 10. An order of magnitude of 10^{-3} was estimated for the pair conversion coefficient after all corrections were made. It did not seem possible, however, to make a quantitative determination with this method, because the solid angle and efficiency of the counters could not be estimated with sufficient precision, particularly without knowledge of the energy distribution of the pairs. A previous study of this type by Bradt *et al.*[2] using thorium C″ was made difficult by internal electron conversion.

In a second experiment the emission of the positrons of the pairs was observed by detecting annihilation radiations. The positrons were stopped in a plastic material surrounding the source and the annihilation quanta were detected by two photomultiplier tubes (E.M.I. 1-in. aperture type; naphthalene–anthracene crystals). These were placed in coincidence (resolving time $1{\cdot}5 \times 10^{-7}$ sec.) and on opposite sides of the source at 65 cm. distance. With this small solid angle (10^{-4} of 4π), coincidences due to the cascade γ-rays of sodium-24 are fewer than those due to pair conversion positrons. Annihilation coincidences were easily distinguished from all others by displacing the source out of the straight line joining the two detectors. A correction for the pairs created in the plastic material by the 2·78-MeV. γ-ray was made by substituting a thickness of aluminium having the same electron stopping power, and repeating the measurement. From the Z^2 law and the observed increase of positron counts, a probability of 3×10^{-4} was calculated for the creation of pairs in the plastic.

The sodium-24 sources (= 70 μC.) were measured after decay on a Geiger counter previously calibrated with another sodium-24 source the strength of which had been determined absolutely by the method of βγ-coincidence. The positron-detecting efficiency of the apparatus was measured with two standards. The first consisted of 900 μC. of radiothorium in a small lead cylinder; in this, positrons are both created and annihilated. Its effective positron strength

(3 μC.) was calculated from data on pair production and γ-ray absorption in lead.

The second standard was a source of sodium-22 in a plastic mounting which had been calibrated against a cobalt-60 standard as follows. The sodium-22 and cobalt-60 sources were placed successively in front of a counter screened by 3 cm. of lead. The ratio of counting-rates remained constant to within a few per cent as the thickness of lead was increased from 3 cm. to 5 cm., justifying the assumption that all annihilation radiation is thus filtered off. Since the γ-energy of sodium-22 (1·28 MeV.) is almost the same as the mean γ-energy of the cobalt-60 lines (1·25 MeV.), this comparison affords a convenient method of calibrating sodium-22 (and hence indirectly any positron emitter).

These two standards agreed to within a few per cent.

A final value of $(7{\cdot}6 \pm 1{\cdot}9) \times 10^{-4}$ was obtained for the pair conversion coefficient of the 2·78-MeV. line of sodium-24. This agrees well with the theoretical result predicted for an electric quadrupole. (Brady and Deutsch[3] have shown that this line is very likely to be a quadrupole transition.) Rae[4] obtained $(11{\cdot}6 \pm 1) \times 10^{-4}$ for the pair conversion coefficient of the same line by a different method, the primary object of which was to determine the spectrum of the positron.

We are indebted to Prof. R. E. Peierls and Dr. G. K. Horton for interesting discussions, and to Lord Cherwell for facilities in this Laboratory.

Note added in proof. In more recent measurements the positrons were stopped in beryllium instead of plastic. A pair conversion coefficient of $(8{\cdot}25 \pm 1{\cdot}05) \times 10^{-4}$ was obtained.

W. Mims
H. Halban
Richard Wilson

Clarendon Laboratory,
Oxford. Aug. 1.

[1] Rose, M. E., *Phys. Rev.*, **76**, 678 (1949).
[2] Bradt, E., Halter, J., Heine, H. G., and Scherrer, P., *Helv. Phys. Acta*, **19**, 445 (1946).
[3] Brady, E. L., and Deutsch, M., *Phys. Rev.*, **78**, 558 (1950).
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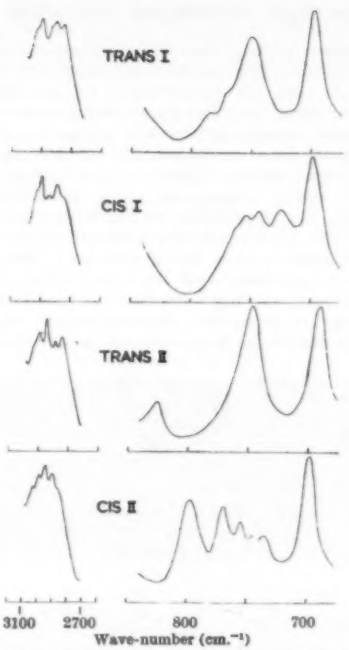
Infra-Red Spectra of Unsaturated Aromatic Carbinols

The infra-red absorption spectra of both the *cis*- and *trans*-isomers of phenyl propenyl carbinol (I) and styryl methyl carbinol (II) have been recorded in these laboratories. Highly purified samples of these compounds were given to us by Dr. E. A. Braude and Mr. J. A. Coles. The *trans*-isomers have been described previously[1]; the *cis*-isomers are new and their preparation will be described separately[2].

Ph.CH(OH).CH=CHMe. (I)
Ph.CH=CH.CH(OH)Me. (II)

In view of the current interest in the C—H deformation frequencies of *cis*- and *trans*-olefines[3–5] and unsaturated alcohols[6,7], parts of the spectra are reproduced here. The *trans*-isomers were expected to absorb at 965 cm.$^{-1}$ and the *cis*-isomers in the 650–750 cm.$^{-1}$ region.

The 965 cm.$^{-1}$ region is unfortunately complicated by absorption due to the COH-group. At lower frequencies the *trans*-isomers gave the normal spectra of mono-substituted aromatics, namely, two strong bands at about 690 cm.$^{-1}$ and 760 cm.$^{-1}$. These two bands (presumably due to aromatic C—H deformation[8]) occur in the spectra of mono-alkyl benzenes, styrene and substituted styrenes, and benzyl and α-substituted benzyl alcohols.



Spectra of unsaturated aromatic carbinols. Spectra recorded on Perkin–Elmer 12*B* spectrometer. 2,600–3,200 cm.$^{-1}$, no dilution, cell 0·025 mm.; 650–850 cm.$^{-1}$, approximately 10 per cent solution in cyclohexane, cell 0·1 mm. Absorption plotted upwards

The *cis*-isomers gave only 690 cm.$^{-1}$ absorption, the other one being replaced by a series of weaker bands. We have, then, the expected absorption due to the *cis*-unsaturation but also a reduction in intensity of the aromatic band. This occurs not only in the spectrum of (II), where conjugation might cause a change in frequencies associated with the phenyl group, but also in that of (I), where the unsaturation is separated from the ring.

In view of this effect on the aromatic C—H deformation frequencies, the C—H stretching absorptions near 3,000 cm.$^{-1}$ were examined. With the limited resolving power afforded by a rock-salt prism, it was found that both *trans*-isomers give a maximum at 2,850 cm.$^{-1}$ where the *cis*-isomers have only a shoulder. This frequency seems too low for an aromatic C—H absorption.

These differences in spectra afford an empirical method of identifying the *cis*- and *trans*-isomers. No attempt has been made to interpret them in terms of molecular structure, although the information may be of use in assigning the absorption frequencies of similar molecules.

Thanks are due to the directors of the Distillers Co., Ltd., for permission to publish this note.

A. R. Philpotts
W. Thain

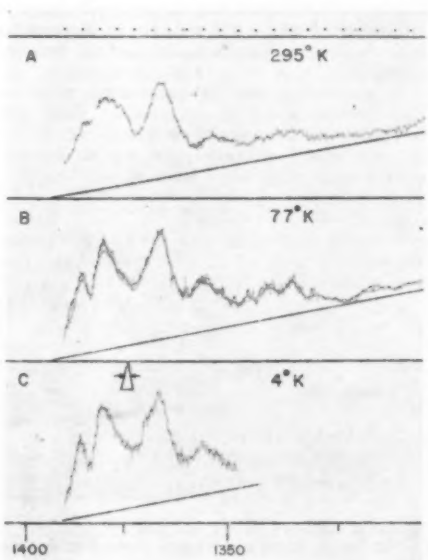
Research and Development Department,
Distillers Co., Ltd.,
Great Burgh, Epsom, Surrey. Aug. 1.

[1] Braude, Jones and Stern, *J. Chem. Soc.*, 396 (1946).
[2] Braude and Coles (forthcoming publication).
[3] Anderson and Seyfried, *Anal. Chem.*, **20**, 998 (1948).
[4] Sheppard and Sutherland, *Proc. Roy. Soc.*, A, **196**, 195 (1949).
[5] Catalogue of Infra-Red Spectrograms (Amer. Petrol. Inst., Nat. Bur. Stand., Washington, 1948).
[6] Crombie and Harper, *J. Chem. Soc.*, 873 (1950).
[7] Sondheimer, *J. Chem. Soc.*, 877 (1950).
[8] Whiffen and Thompson, *J. Chem. Soc.*, 268 (1945).

Effect of Low Temperatures on Infra-Red Spectra

A MAJOR portion of infra-red spectroscopy to-day is directed toward the determination of characteristic vibrational frequencies of polyatomic molecules. In almost all cases the information is limited because the broad bands overlap. Cooling the sample to low temperatures offers the possibility that the natural width of each band is reduced sufficiently to resolve individual vibrational frequencies. The extent of the improvement has recently been the subject of a considerable amount of controversy. Walsh and Willis[1] and we[2] have pointed out that, in general, quantized rotation does not occur in condensed phases, so that one cannot agree with Avery, Morrison and Ellis[3], who stated that narrowing would obey the very strong law, $\sim T^{1/2}$, characteristic of rotational structure. However, we cannot agree with Walsh and Willis that narrowing can only occur through a change of state. On the contrary, on very general grounds[2,4], some narrowing would be expected from depopulation of the Debye acoustic waves, which are coupled with the molecular vibrations to give width to the bands.

We have subjected these ideas to fairly rigorous test by examining the infra-red spectra of a number of compounds at the temperature of liquid helium (4° K.)[2,5,6]. In order to interpret these spectra, we have made[7] a detailed treatment of resolving power and apparent width, taking into account the natural width of the bands, the aperture of the spectroscope, two finite slits, absorption of the prism, rate of scanning and the filtering of noise. The observed width is a transcendental function of the half-widths characterizing these factors, and can be roughly approximated as the square root of the sum of the squares, which explains why no startling changes are to be seen with present-day equipment. Applying the exact relation to data at 77° K. in the literature, we conclude the observed band-widths have been primarily determined by the experimental conditions. We have demonstrated this by re-examining the same or similar compounds at low temperatures with higher resolving power and have revealed more structure.



In our own spectra, the natural width at 77° K. is equal to that of the instrument, and at 4° K. the bands have become narrower. The accompanying illustration shows the spectrum of crystallized[8] cholesterol at 295° K., 77° K. and 4° K. (This work was done with a grant-in-aid from the American Cancer Society.) There is an increase in definition which we can interpret as a reduction in the natural width of the bands, without invoking a change of phase.

We conclude that considerably more detail of the spectra of such large molecules can be obtained at very low temperatures due to a reduction in natural band-width, provided the spectroscope has sufficient resolving power.

R. M. HAINER
G. W. KING

Arthur D. Little, Inc.,
Cambridge, Massachusetts.
Oct. 9.

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[4] Hornig, D. F., *J. Chem. Phys.*, **16**, 1063 (1948).
[5] Abstracts of the 115th Meeting of the Amer. Chem. Soc., 43 (1949).
[6] Hainer, R. M., and King, G. W., *Phys. Rev.*, **70**, 473 (1949).
[7] A detailed account of this treatment is to be published elsewhere.
[8] The sample was prepared by a modification of the technique described by McMahon, H. O., Hainer, R. M., and King, G. W., *J. Opt. Soc. Amer.*, **39**, 786 (1949).

New Source of Light for the Far Ultra-violet

THE Millikan spark[1], which is widely used in the far ultra-violet, presents some drawbacks because of the very high fields necessary for its initiation, and the instability of its operation. It is known that, at atmospheric pressure, very long sparks can be obtained with moderate potentials, if they are produced along the surface of a solid (sliding sparks). So far as we know, this spark had not been tried in a good vacuum, and it was not at all sure that it could be operated without an appreciable gas pressure. This communication describes a few results obtained with one type of sliding spark operated at low pressures.

Our experiments have been performed in a metallic spark chamber, evacuated by a diffusion mercury pump, followed by a liquid-air trap, the pressure being lower than 10^{-4} mm. mercury. The voltage is applied between two metallic rings mounted on a rod of commercial carbon resistor. The spark is supplied by the discharge of a condenser (0·03–0·1 F) charged at 30 kV. The spark chamber is mounted on front of the slit of a vacuum grazing-incidence grating spectrograph.

These experiments have been successful. Under the potential of 30 kV. the discharge is produced easily even for large interspaces (a few centimetres) between the electrodes. But this discharge does not look like the sliding sparks in gases, as its luminosity is mainly concentrated around the electrodes.

The negative electrode wears out, but this effect is slow, and the projections of solid particles are much weaker than in ordinary vacuum spark. More.

over, the sliding spark is stable in space and more steady than the Millikan sparks; it works without any adjustments at all during many hours (for a frequency of two sparks a second).

The spectra we have obtained with copper electrodes (separation 3 mm.), between 100 and 2000 A., are, at first sight, similar to those given by ordinary vacuum sparks, except that some carbon lines are also present. From our results, it appears that 'sliding sparks' in vacuum will probably be useful as light sources for far ultra-violet spectrography. The spectrographic study of various types of 'sliding sparks' in vacuum is now in progress.

B. Vodar
N. Astoin

Faculté des Sciences de Paris,
Laboratoire de Physique,
1 Rue Victor-Cousin,
Paris, 5e.
July 27.

[1] Millikan and Sawyer, *Phys. Rev.*, **12**, 167 (1918); *Science*, **50**, 138 (1919). Bombke, "Vakuum spektrocospie" (Leipzig, 1937). Vodar, Progrès récents dans l'étude du spectre U.V. Centre de perfectionnement technique (Cours conférence No. 1116, Nov. 1943).

Muscle Fibres of the Rat Diaphragm

In the course of an investigation of nerve endings in the rat diaphragm, it was noticed by Dr. J. A. Hewitt and one of us (C. S.) that the muscle fibres seemed to be of two types, reminiscent somewhat of the well-known pale and red fibres in voluntary muscles described by Jordan[1] and several others. The 'red' variety seemed to be more numerous than the other. Staining with iron hæmatoxylin after alcohol fixation (ideal for skeletal muscle) confirmed that there were two types, but unfortunately did not reveal any further distinguishing detail. It was then decided to attempt their differentiation at the higher magnifications now possible with the electron microscope.

The technique of specimen preparation was similar to that described by Hall, Jakus and Schmitt[2], but was slightly modified to suit our particular tissue. A three-stage electron microscope built under the direction of Prof. G. I. Finch was used for this work, with an operating voltage of 80–120 kV.

For the first part of our work specimens were prepared from fresh pieces of diaphragm in the relaxed state. Krause's membrane is not confined to one myofibril, but is continued through those adjacent to it. The myosin filaments can be resolved in some specimens but not all, and extend throughout the length of the fibril. No limiting membrane can be seen surrounding the myofibril.

Two types of fibril were again observed in the electron microscope, which showed that though they are similar in most respects, they differ in their sarcomere lengths, especially after passive stretching (extending). This is due to a difference in the relative extensibilities of the *A* and *I* bands of the two fibrils, which is presumably a result of the difference in the structure of their *A* bands, since there is independent evidence that the *I* bands are similar, whereas the *A* bands are different in their staining reaction.

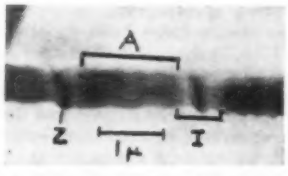

Fig. 1. Electron micrograph of a myofibril from rat diaphragm in the relaxed state

For the second part of our work we compared stimulated diaphragm muscle fibrils in both the contracted and the relaxed states. The former was obtained by stimulating the phrenic nerve, allowing the fibres to contract isotonically and fixing them in this condition. The latter was obtained by stimulating, as before, another piece of diaphragm, and after isotonic contraction the stimulus was stopped; the muscle then lengthened to the relaxed state in which it was fixed.

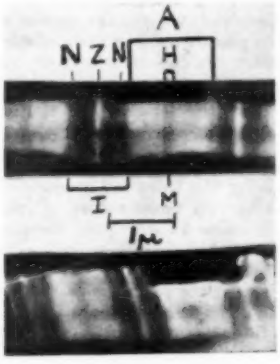

Fig. 2. Electron micrographs of fibrils from (*a*) rat rectus and (*b*) rat diaphragm, both after stimulation. The *H* disk and the *M* and *N* lines now appear

The fibrils from stimulated diaphragm exhibit more detail than those from one not so stimulated. The *A* band now shows Hensen's disk with the *M* line within it, and the *I* band shows the *N* lines in some fibrils.

Changes in sarcomere lengths in both 'pale' and 'red' fibres occurring of necessity in isotonic contraction are seen most noticeably in the lengths of the *I* bands.

Our observations are in agreement with those reported by Hall *et al.*[2] on leg muscles of the rabbit.

A few observations were made on the rectus muscle of the rat, which indicate that similar structural alterations take place after stimulation.

A fuller account of this work will be published elsewhere. We wish to thank Prof. G. I. Finch for his help and for giving us facilities in his laboratory, and Dr. J. A. Hewitt for suggesting the original work and for criticism.

C. Sitaramayya

Department of Physiology,
King's College,
London, W.C.2.

M. M. Bluhm

Applied Physical Chemistry Laboratory,
Imperial College of Science and Technology,
London, S.W.7.
Sept. 15.

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The Cuticle of Mammalian Hair

STUDIES in these laboratories have suggested that the arrangement of scales in the cuticles of mammalian hairs can be more accurately revealed by the examination of fibre sections, using ultra-violet light, than by the use of the electron microscope. This work has shown that the thickness of the cuticle of mammalian hair depends upon the arrangement of the component scales.

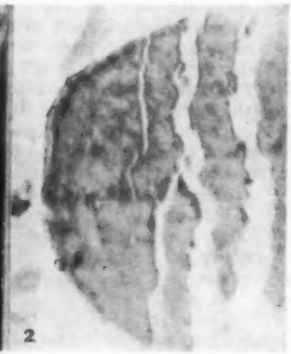
Thin transverse and longitudinal sections of human hair, hog bristle, alpaca and wool have been prepared at thicknesses varying from one to five microns. After staining some of the sections by the Champy–Kull method and others with indigo-carmine, they were examined under the phase-contrast microscope and the normal microscope, using the 3650 A. line.

Thickness of cuticle, as can be seen in a longitudinal section of human hair (Fig. 1), depends upon the number of layers in the cuticle, these being formed by the amount each scale overlaps its neighbour. The cuticles of human hair, hog bristle and alpaca are comparatively thick. The whole cuticle can be seen quite clearly under the $\frac{1}{6}$-in. objective, and individual scales which form the cuticle are clearly seen under the $\frac{1}{12}$-in. objective. In human hair these scales are approximately 0·33 micron thick and approximately 30 microns in length; the latter measurement being taken from a point on the lower margin of the scale, which abuts on to the cortex, to a point on the upper margin of the scale which is on the surface of the fibre. (These measurements were made on photomicrographs of longitudinal sections of fibres.) Of this length, only about one-sixth forms the outer surface of the fibre, the remaining five-sixths being covered by the adjacent overlapping scale. The result of this is a scale pattern where the scale margins are relatively close together, as seen in human hair and hog bristle.

Longitudinal sections of Lincoln and Leicester wool fibres show that individual scales are approximately the same length as the scales in human hair but in some cases thicker, up to 0·66 micron. The proportion of longitudinal overlap is the reverse of human hair, namely, only approximately one-sixth of the total length is covered by another scale, and five-sixths of the length forms the outer surface of the fibre. It may be noted that both these types of wool fibres have a scale pattern with scale margins fairly widely spaced.

1

Longitudinal section (8 μ) of human hair (ultra-violet light, 3650 A.; × 930)



2

Transverse section (5 μ) of Leicester wool fibre (phase contrast; × 1,000)

Both transverse and longitudinal sections of wool fibres show that the cuticle is much thinner than the cuticle of human hair, hog bristle or alpaca, due to a different arrangement of scales. In a wool fibre the cuticle is only one scale thick except in parts where the scale overlaps. Fig. 2 is a typical example of a transverse section of a wool fibre. In the other fibres mentioned above the cuticle is thick, due to closely overlapping scales. In both types of fibres, scales overlap in a lateral direction, showing that one scale does not extend around the whole circumference of the fibre. In human hair overlapping scales can be seen within and on the surface of the cuticle.

H. M. APPLEYARD
C. M. GREVILLE

Wool Industries Research Association,
Leeds.
Aug. 18.

X-Ray Diagram and Ultra-Violet Absorption Spectrum of 'Renatured' Silk-Fibroin

Coleman and Howitt[1] have observed the interesting fact that if one dissolves denatured silk-fibroin in cupriethylene-diamine, a product is obtained which does not differ essentially from the native fibroin, and therefore they have called it the process of "renaturation".

In an earlier communication[2], we have stated that the air-dried native silk gland gives a very sharp X-ray diagram which by means of mechanical treatment of the sample, for example, stretching and rolling, changes into the well-known diagram of the cocoon filament. We suggested the names 'Silk I' and 'Silk II'. If 'Silk II' is treated with alkali, there appear small-angle interferences at the equator, which are due to a 45-A. net plane distance in the side-chain direction. This form of the silk we named 'Silk III'[3].

In view of these results, it seemed of considerable interest to investigate the renatured silk of Coleman and Howitt. If the dialysed aqueous solution of the fibroin is dried *slowly*, films are obtained with the diagram of 'Silk I'. Nevertheless, the diagram is much less pronounced than the diagram obtained from the native silk gland. Only two reflexions allowed satisfactory measurement, namely, those with values of D of 7·3 A. and 4·4 A. They correspond quite definitely, both in appearance of the diagram and density distribution in the diffuse background, with the reflexions formerly found of 7·5 and 4·5 A. This points to a distinct, if insignificant, contraction of the lattice.

If moistened with 50 per cent ethanol, the renatured silk films could be stretched plastically more than 300 per cent without losing their solubility in water and without any increase in tensile strength. The X-ray diagram of these stretched films shows no orientation. But the sharp diagram changes into a smeared amorphous diagram with two maxima which are identical with the strongest reflexions of 'Silk II', about 9·2 A., corresponding with A_1, and 4–4·8 A., corresponding with the region of the

strongest reflexions A_2 and A_2'. Between crossed nicols, no birefringence is to be seen. This gives the impression that a transformation is beginning from 'I' into 'II', which has, however, not yet led to the formation of long particles; hence on stretching there occurs a plastic deformation without any orientation.

The transformation into the diagram of 'Silk II' with fibre orientation does not take place until the moistened films are stretched and rolled at the same time. The strongest intensity of 'Silk I', with a net plane distance of 4·4 A., still remains as a continuous faint circle.

Certain differences between this fibre diagram and that obtained by stretching and rolling the native silk gland could be observed. Thus fibrous particles, when stretched approximately 100 per cent, would lead to a much better orientation than is actually observed. The weakness of the reflexions A_1 and A_2—the latter cannot be observed with any certainty—coinciding with the plane of the peptide grid probably indicates a disturbance or irregularity in the direction perpendicular to the backbone plane. The dominating reflexions are A_2 and A_2'. Both these reflexions belong to the zone of the c-axis, indicating the side-chain direction.

The treatment of renatured silk with hot alkali yielded no positive results; in particular, it did not lead to small-angle reflexions at the equator. This fact, too, points to a low degree of order in the direction perpendicular to the peptide grid.

The only effect of the hot alkali consisted in a distinct increase in intensity of the reflexions, that is, in an augmentation of the lattice-like part. This effect is in good accordance with the ultra-violet spectrographic observation that treatment with alkali results in the appearance of an additional absorption band at about 4,000 mm.$^{-1}$. This band has been ascribed to the enolic form of the peptide group[5]

which is possible only on the basis of extended systems of interchain hydrogen-bonds. Thus, the alkali treatment leads, just as in the case of the native silk, to a better-ordered arrangement within the plane of the peptide grid. The renatured silk, however, is unable simultaneously to form a long-range order in the side-chain direction. Coleman and Howitt emphasize that rapid drying of the fibroin solution is necessary for obtaining samples which show on stretching an increase in tensile strength and birefringence. They say, furthermore, that these samples give the normal β-diagram of the silk (corresponding to 'Silk II'). Judging from the mechanical and optical behaviour, we believe that what these authors were working on was, in fact, 'Silk II'. If, on the other hand, the solution is dried slowly, 'Silk I' will be formed as stated above.

Thus, we may conclude that the mechanical deformation, stretching and simultaneous rolling, has the same effect as the rapid drying mentioned by Coleman and Howitt. The fact that these authors are able to identify in their solutions a globular form of the protein confirms our opinion that 'Silk I' obtained from this solution by drying very slowly represents a globular protein[2].

Our investigations are being continued. We are much obliged to J. Lapp and W. Berndt for preparing the silk samples.

O. Kratky
E. Schauenstein
A. Sekora

Institute for Theoretical and
Physical Chemistry,
University, Graz.
Aug. 16.

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Diffusion of Copper along the Grain Boundaries of Nickel

Langmuir[1], when studying the thermionic emission of filaments for electronic valves, reported that the diffusion of thorium in tungsten may be a hundred times faster along the grain boundaries than through the grain itself. Van Liempt[2] and Zwikker[3], respectively, gave similar results for molybdenum and carbon in tungsten. Mehl[4] stated that copper diffused preferentially along the grain boundaries of aluminium, but that there was no detectable preferential grain-boundary diffusion of carbon, nitrogen or hydrogen in iron. Also Seith and Keil[5] were unable to detect any grain-size effect in the self-diffusion of lead. Evidence is given in this communication showing that copper diffuses preferentially along the grain boundaries of nickel.

Thin copper and nickel strips of commercial purity, stacked alternately, were annealed in an atmosphere of hydrogen to remove the surface oxide films, and then hot-rolled together. This treatment gave very good bonding between the two metals, and no flaws could be seen microscopically in the interfaces. Nickel and copper were chosen because they have complete solubility and hence there are no intermediate phases to complicate the diffusion zone. After annealing the sandwich at 1,000° C. for 36 hr. in an argon atmosphere, the cross-sectional surface was polished on emery papers to grade 000 and then electrolytically polished using a bath of one part concentrated nitric acid and two parts methyl alcohol. A current density of 1·5 amp./cm.^{2} for 3 sec. with 20 V. across the cell was sufficient to remove the mechanically worked material, and by rapidly interrupting the current about three times at the end of this treatment it was possible to pit the material with a high nickel content without etching the copper-rich material. The accompanying photomicrograph (Fig. 1) shows that the concentration contour is quite sharp, and that the copper diffused more rapidly along the grain boundaries of the central nickel than through the grains themselves.

It is of interest that twin boundaries in the nickel do not influence the diffusion-rate, there being no modification of the advancing concentration contour at twin boundaries, for example, AB (Fig. 1). This fact is in accord with the suggestions made by Beck, Sperry and Hu[6] to explain their results on the

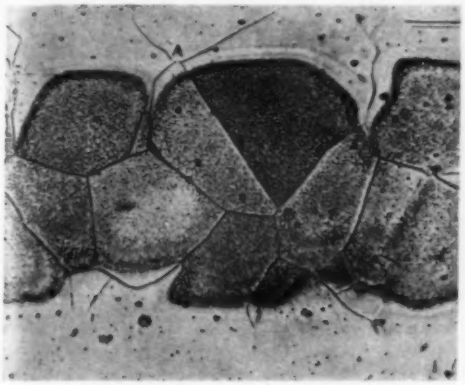


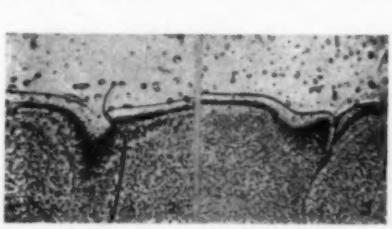
Fig. 1. Micrograph of copper-nickel sandwich showing the preferential diffusion along the grain boundaries but not the twin boundaries (for example, *AB*) of the central nickel. (× 325)

dependence of the rate of grain boundary migration on orientation.

Figs. 2 and 3 show examples of the movement of a grain boundary from the position where it has caused a V-shaped inlet in the concentration contour to a new position, and are proof that the diffusing copper atoms do not lock the nickel grain boundaries and prevent grain growth. The boundary in Fig. 2 has moved from its former position quite late in the annealing process as there is no inlet centred upon its present position, while that in Fig. 3 has moved to its present position sufficiently early during annealing for a new inlet to be formed and for the old inlet to lose its sharpness.

It may be noticed that Figs. 2 and 3 both contain two concentration contours. It was found that by suitable choice of current density, one, two or three concentration contours could be made to show on the micrograph; some of these contours being as sharp as grain boundaries.

The extent of the penetration of copper along a grain boundary of the nickel cannot be used as a measure of the rate of diffusion, as it is dependent upon the length and inclination of the boundary. However, the angle of the apex of the concentration contour at a grain boundary may be used as a measure of the relative rates of diffusion along the grain boundary and through the crystal lattice. Measurements of this nature on various grain boundaries in Fig. 1 give values of between 1·5 and 4 for the ratios of the diffusion-rates. Micrographs with more than one concentration contour show that the ratio becomes less as the concentration of the copper increases.



Grain boundary which has moved to its present position: Fig. 2 (left) at the end of the anneal; Fig. 3 (right) quite early in the anneal. (× 325)

There is no indication in Fig. 1 that the volume diffusion of copper into the nickel is dependent upon the orientation of the grain, and this is as expected in cubic metals.

This simple method of studying grain boundary diffusion has the advantage of bringing out clearly the details of the processes, whereas the method of measuring the diffusion coefficient as a function of grain size gives only a statistical result. The method can be used to study recrystallization and grain growth caused by diffusion, as a detailed study of the micrographs gives information upon the existence and position of grain boundaries during the whole period of annealing. The shape of the concentration contours where they cross grain boundaries will give valuable information on the ratio of grain boundary to lattice diffusion and thus on the nature of the grain boundaries themselves.

R. S. Barnes

Metallurgy Division,
Atomic Energy Research Establishment,
Harwell, Berks.
Aug. 18.

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Molecular Models

The report of a method of making Stuart-type molecular models in plastic[1] prompts us to describe a procedure evolved here which is very cheap and requires only very simple means.

From a standard model of each atom a copy can quickly be made with the kind of charcoal used for blow-pipe analysis. A wire is stuck into one face and the copy slowly lowered into a crucible of molten scrap type-metal until the face bearing the holding wire is level with the surface of the metal. After agitating the metal for a while to dislodge air bubbles, it is allowed to solidify. The charcoal is then dug out piecemeal and the inner faces of the mould carefully polished. This is tedious but largely determines the appearance of the finished models.

In some cases, split moulds are needed and these are made by sawing the metal in half, making an aluminium gasket and arranging some pegs to register the two halves.

Any number of final models can now be made from the mould by pouring in polyvinylchloride paste (for example, "Welvic" grade *PA*2), suitably coloured with pigments. The mould is closed by a metal plate and *G*-clamp, heated for 15 min. at 160° C. and the model stripped from the mould after cooling in water.

The separate atoms can be welded together permanently by a hot knife or joined by ¼-in. pegs or by small dressmaker's press-studs. The female portions of these may be moulded into the appropriate faces of the models, where they are well anchored by the polymer. To fit into these, a small pin with a head size just fitting the press-studs may be pressed into the adjacent atom model. From such atoms it is

possible to construct strong models with free rotation at any desired point.

G. L. Mills
D. M. P. Phillips

Courtauld Institute of Biochemistry,
The Middlesex Hospital
Medical School,
London, W.1.
Aug. 24.

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A Water-Labile Fungistatic Extractive characterizing Living Trees

The ability of living trees to resist attack by common fungi which destroy dead branches and lumber from these same trees seems to be in need of explanation. This problem is made more interesting by the fact that some wood-destroying fungi, such as *Schizophyllum commune* Fries, are in general unable to cause serious trouble even in wounded living trees.

The following method was used to demonstrate the fungistatic properties of extractives from catalpa (*Catalpa speciosa* Warder). Ground samples of heartwood, sapwood (the outer annual ring), and bark were extracted with 95 per cent ethyl alcohol. Pieces of filter paper were placed in the filtrate and then sterilized and dried in a hot-air oven. Two pieces of the filter paper were placed one inch apart on potato dextrose agar in a 'Petri' dish. *S. commune* was then inoculated into the agar equidistant from the papers. Filter paper similarly treated but placed in alcohol only was used in controls. Inhibition of radial growth was found to be in proportion to the concentration of extractive used—with heartwood extract giving most inhibition, followed by sapwood and then bark. Fungistatic materials have also been obtained by hot-water extraction, although, even after boiling in water for three hours, alcoholic extractives of high inhibiting potency have been demonstrated in the wood. Studies of materials from other tree species indicate a general prevalence of similar fungistatic substances, there being a quantitative difference in distribution. For example, the elm (*Ulmus americana* L.), the fallen timber of which is rapidly subject to decay by *S. commune*, contains comparatively small amounts of the inhibiting substance in wood taken directly from living trees.

Alcoholic extracts have retained their antibiotic nature, but water extracts have been found to lose this property rapidly. It has also been shown that there is a negative correlation between fungistatic capacity of alcoholic extractives and the length of time the branches are stored at room temperature in laboratory air or in water.

The fungistatic substances here described may be similar or identical with those previously reported but not correlated with relative resistance of living and dead trees[1,2], etc. This, and the ability of the extractive to inhibit other fungi, is yet to be determined. That there may be a connexion between these fungistatic materials and growth-regulating substances is suggested by the observation that dilute concentrations seem to have a stimulating effect[3]. Whatever the nature of these materials, the results of the experiments here reported present evidence that living trees contain substances which rapidly lose their antibiotic qualities upon the death of the tree.

E. S. McDonough
Lois Bell
Georgia Arnold

Biology Department,
Marquette University,
Milwaukee 3,
Wisconsin.
Aug. 9.

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Mechanism and Significance of the 'Refractory Period' in the Avian Testis Cycle

Burger[1] asserts that the "problem of refractoriness is perhaps the greatest relatively unsolved problem in reproduction". This problem, except in its ultimate details, may, in fact, have been solved[2]. It can be said that the "refractory period" (of Bissonnette[3]) or "dead sexual season" (of Polikarpova[4]) in seasonal birds is that part of the testis cycle during which the tubules are in a state of post-spermatogenetic lipoidal metamorphosis, and before the newly regenerated Leydig cells of the interstitium have become sufficiently mature and lipoidal to respond to neuro-humoral influences initiated by factors in the environment.

At the termination of spermatogenesis, the epithelial contents of the tubules metamorphose and disintegrate, the tubules themselves become reduced in diameter and the whole organ collapses. Concurrently, the exhausted Leydig cells (almost denuded of their lipoids during the last stages of the sexual season) of the old generation disappear, and there arises a new generation in the spaces between the shrunken tubules. Fibroblasts suddenly appear in great numbers and rapidly build up a new *tunica albuginea* just inside the old testis wall that has become thin, distorted and fragile due to its enormous spring expansion and to its sudden collapse during tubule metamorphosis.

This phase of breakdown and re-organization is associated with the post-nuptial moult and is probably responsible for the period of complete, or almost complete, sexual quiescence that now ensues. Also, during this time, experimental birds are 'refractory'—they cannot be forced into spermatogenesis by means of photostimulation. When the interstitium becomes again responsive, many species undergo a characteristic post-nuptial sexual display[5]. This occurs while the latter phase of the moult is still proceeding and while the tubules are still partially, and sometimes massively, lipoidal (Marshall and Coombs, unpublished). Most of the necrotic sperm debris has, however, been eliminated. The 'refractory period' varies in duration from species to species.

In the light of the above, it can be readily understood why Bissonnette and Wadlund[6] were unable quickly to achieve a second experimental spermatogenesis by photostimulation, and why Riley[7] failed to obtain light-induced spermatogenesis in September, yet succeeded in doing so in November. Likewise, Riley's success in stimulating juvenile birds in September becomes understandable, since these had not already undergone spermatogenesis and interstitial exhaustion and so their tubules had not

metamorphosed and their developing lipoid Leydig cells were receptive to neurohumoral stimuli induced by the additional illumination.

The above-described tubule steatogenesis differs markedly from that which has long been known to occur in the semeniferous tubules of non-seasonal man. In adult man the abundant sudanophil material comes almost exclusively from changes in the Sertoli cells and not from cyclical germ-cell breakdown. Further, unlike those of birds, the tubule lipoids of man are not cholesterol-positive (Marshall and Boswell, unpublished). It is of interest that during the single, restricted period of the year when the endocrine Leydig cells of the seasonal bird are very immature and wholly inactive, the lipoids within the neighbouring tubules give a strongly positive reaction for cholesterol, the probable precursor of the androgens. Further, an equally well-marked cholesterol reaction is obtained in atretic follicles of the regressed avian ovary.

A. J. Marshall

Department of Zoology and
Comparative Anatomy,
St. Bartholomew's Hospital Medical College,
University of London,
London, E.C.1.
Aug. 22.

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Growth Inhibition of a Yeast by Uracil, and its Reversal by Arginine

Adenine, guanine and uracil have been shown by Holland and Meinke[1], to inhibit the growth of *Streptococcus fæcalis* R., the inhibition being reversed by serine. We have observed a similar inhibition of the growth of a yeast, *Saccharomyces cerevisiæ* strain *D.C.L.* 349, by uracil, which is reversed by arginine.

The synthetic medium used contained glucose, mineral salts, ammonia, biotin, pantothenic acid, aneurine, pyridoxine, inositol and nicotinamide, with or without adenine, guanine and xanthine. The addition of concentrations of uracil greater than $1{\cdot}5 \times 10^{-6}$ *M* to medium inoculated with 10 gm./ml. of yeast 349 and shaken at 30° inhibited the growth for about four days, whereas at $0{\cdot}1 \times 10^{-6}$ *M* there was, in some cases, slight stimulation. Without uracil the yeast grew to completion in 24 hr. L-Arginine added at about one-third of the concentration of uracil completely reversed the inhibition over a range of $0{\cdot}5$–50×10^{-6} *M*. DL-Citrulline at concentrations forty times greater had a similar action to L-arginine. The inhibitory effect was not counteracted by twenty other amino-acids, including ornithine, added singly or in combination, or by folic acid, urea, or the guanidine bases glycocyamine, creatine, agmatine and guanidine. The growth of nine other yeasts, *S. cerevisiæ* strain *D.C.L.* 211, *S. cerevisiæ* strain *alpinus*, *S. carlsbergensis* 4428, *S. macedoniensis*, *S. logos*, *S. fragilis*, *Torula colliculosa*, *T. cremoris* and *Kloeckera brevis*, was slightly stimulated by uracil, rather than depressed. The specificity of the action of uracil was tested by substituting the following related compounds, none of which showed a similar effect: namely, alloxan, alloxantin, allantoin, cytidine, *iso*cytosine, barbituric acid, *iso*-barbituric acid, orotic acid, 5-amino-uracil, 5-nitro-barbituric acid, dialuric acid, violuric acid, *iso*-violuric acid, 2-thiouracil, 2-methyl-4-amino-5-ethoxymethyl-pyrimidine and thymine.

In view of a similar antagonism described by Volcani and Snell[2] between arginine and its structural homologue canavanine, a sample of canavanine, kindly given by Dr. C. J. O. R. Morris, was tested and found to inhibit the growth of typical strains of the genera of yeasts mentioned above, and in all cases the effect was reversed by arginine. Hence it is concluded that canavanine effects a mechanism which is common to most yeasts, whereas the action of uracil is of a more specific nature.

E. J. Miller
J. S. Harrison

Research and Development Department,
The Distillers Co., Ltd.,
Epsom, Surrey. July 31.

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Phase Coloration in Larvæ of Lepidoptera

About thirty years ago Uvarov brought forward the 'phase' theory of locusts and showed that young hoppers when crowded together developed differences in colour, structure, behaviour and physiology from similar larvæ kept individually separate. The former were known as the phase 'gregaria' and the latter as 'solitaria'. Gregaria are always darker in colour than solitaria.

In 1943 Faure announced the discovery of phases in larvæ of two South African Lepidoptera of the family Noctuidæ, *Laphygma exigua* (the lesser army worm) and *L. exempta* (the army worm), with the possibility of its occurrence in a third species *Spodoptera abyssinia*.

We have recently carried out two repetitions of an experiment on larvæ of *Plusia gamma* (the silver-Y moth), in each case from a single batch of eggs, some of the larvæ crowded and others kept solitary. All the solitary caterpillars remained pale green, while the crowded larvæ changed from a green darker than that of the solitaries to an extremely dark coloration. These laboratory experiments are supported also by some field observations (which led to the investigation) in which unusually dark larvæ were associated with mass outbreaks.

It is curious to note that, with the exception of *S. abyssinia*, all the Lepidoptera in which phases have been demonstrated are migratory species, similar to the locusts, but why there should be the connexion and if it is more general cannot yet be answered.

Further experiments are now in progress on the chemical and physical aspects of the physiological differences, and on the behaviour patterns, in *P. gamma* and also in other species such as *Pieris brassicæ* (the large cabbage white butterfly), which is a well-known migrant, and other non-migratory Lepidoptera.

Fuller details will be published later.

C. B. Williams
D. B. Long

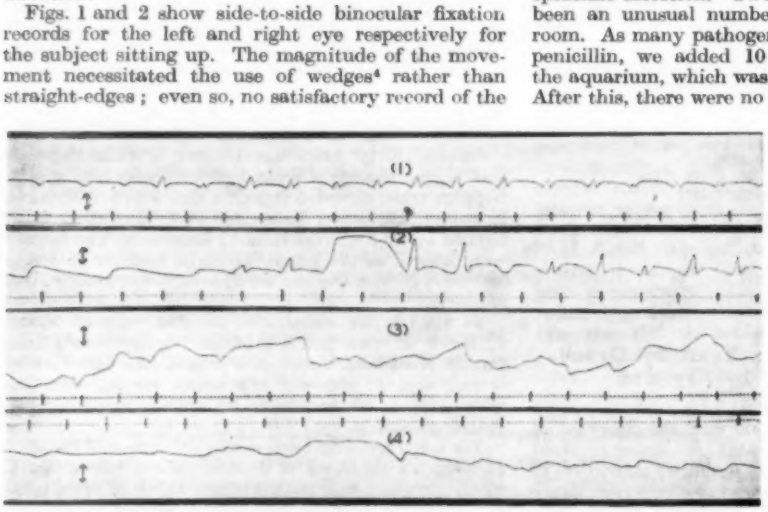
Department of Entomology,
Rothamsted Experimental Station,
Harpenden, Herts.
July 30.

Nystagmus following an Emotional Disturbance

SINCE it is possible that eye movement research will have important clinical applications[1], the photoelectric corneal reflex method[2,3] has been applied to the study of a case of nystagmus.

The subject is a male, twenty-two years of age, and, apart from the nystagmus, free from pathological conditions. The history is that, at the age of nine years, an enforced change from left- to right-handedness produced a nervous crisis the aftermath of which was the nystagmus. There is now no subjective disturbance in vision, and, to the best of the subject's knowledge, the nystagmus has not changed since its inception. The movements are visible to the unaided eye and any emotional upset causes a considerable increase in their magnitude; the movements appear to be confined to the side-to-side direction.

Figs. 1 and 2 show side-to-side binocular fixation records for the left and right eye respectively for the subject sitting up. The magnitude of the movement necessitated the use of wedges[4] rather than straight-edges; even so, no satisfactory record of the movements of both eyes simultaneously has yet been obtained. Figs. 1 and 2 show the nystagmus some 7 min. from the beginning of fixation; initially, the movements are too large to record with the existing apparatus; this is also the case after prolonged fixation. At an intermediate stage, as the beginnings of Figs. 1 and 2 show, the phenomenon disappears almost entirely. It appears that the nystagmus is of neither the usual pendular nor the usual jerky type[5]; it is, however, characteristically regular, interval 0·23(7) sec.



(1) and (2). Side-to-side records for the left and right eye respectively. Towards the time-line corresponds to a rightward movement.

(3) and (4). Up-and-down records for the left and right eye respectively. Towards the time-line corresponds to an upward movement.

Time (increasing to right) marked by dots, 50 per sec., and by lines at 1/5 sec. intervals.

Amplitude shown at side; height of arrowed line represents a rotation of 2° for Figs. 1 and 2, of 20' for Figs. 3 and 4; it is assumed that the separation of the centre of curvature of the cornea and the centre of rotation of the eye is 5·3 mm.

Figs. 3 and 4 show up-and-down records for the left and right eye respectively under the same conditions as for Figs. 1 and 2. These records are not very different from those of normal subjects[3].

It would appear that these results provide one more illustration of the close linkage between psychological and physiological phenomena.

I am greatly indebted to Mr. J. S. Swain for acting as subject in this investigation; and I wish to express my thanks to Dr. W. D. Wright for helpful criticisms. I also acknowledge the continued financial support of the Medical Research Council.

MARY P. LORD

Technical Optics Section,
Imperial College of Science and Technology,
London, S.W.7. July 31.

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Penicillin in the Aquarium

AXOLOTLS were hatched from eggs in the laboratory and kept in an open tank. Progress was satisfactory until they were about 1 in. long (8 weeks), when considerable numbers died suddenly, suggesting an epidemic infection. Two days previously there had been an unusual number of people present in the room. As many pathogenic agents are susceptible to penicillin, we added 10 units/ml. to the water of the aquarium, which was then not changed for 24 hr. After this, there were no more deaths. Shortly afterwards we had similar losses among our edible frogs, kept in a shallow tank. Penicillin was added to the water, a higher concentration—20 units/ml.—being used to allow for the slower entry into the larger animals. There was an immediate and striking reduction in the mortality-rate to a figure no greater than normally experienced with these animals at that season.

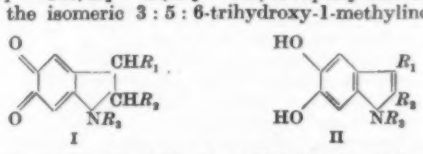
Though no attempt was made to demonstrate a pathogen beyond the microscopic observation of a Gram-positive diplococcus in both cases, we feel that the observations might be of interest to others responsible for the maintenance of aquaria.

H. K. KING

Biochemistry Department, Johnston Laboratories,
University, Liverpool 3. July 28.

Synthesis of 5:6-Dihydroxyindole Derivatives: an Oxido-reduction Rearrangement Catalysed by Zinc Ions

IT has recently been shown[1] that adrenochrome (I, R_1 = OH, R_2 = H, R_3 = Me) is rapidly converted into the isomeric 3 : 5 : 6-trihydroxy-1-methylindole



(II, R_1 = OH, R_2 = H, R_3 = Me) by the action of zinc acetate in aqueous solution. We have now found

that this interesting catalysed oxido-reduction rearrangement is general for compounds of the type (I) and provides a very convenient synthetic route to dihydroxyindoles which are of interest as melanin intermediates.

Thus, 3 : 4-dihydroxyphenylalanine, on treatment with 4 mol. equivalents of potassium ferricyanide and sodium bicarbonate, gives a deep red solution of a quinone (I, $R_1 = R_2 = H$, $R_3 = CO_2H$), which on treatment with an excess of zinc acetate, removal of the precipitated zinc ferrocyanide by centrifugation and extraction of the aqueous solution with ether, gives an excellent yield of 5 : 6-dihydroxyindole (II, $R_1 = R_2 = R_3 = H$), identical with that synthesized by a longer route by Beer, Clarke, Khorana and Robertson[2].

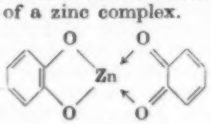
The red quinone can also be obtained by oxidation of 3,4-dihydroxyphenylalanine with tyrosinase or silver oxide[3], but the use of potassium ferricyanide, as described above, is much superior for preparative purposes. Exactly similarly, 5 : 6-dihydroxy-1-methylindole (II, $R_1 = R_2 = H$, $R_3 = Me$), earlier prepared by one of us[4] by the reduction of adrenochrome, was obtained from N-methyl 3,4-dihydroxyphenylalanine. In both the above cases, rearrangement and loss of carbon dioxide have occurred simultaneously, conforming with the observations of Mason and Wright[5].

Application of the above procedure to 3 : 4-dihydroxyphenylethyl methylamine (epinine) also gave 5 : 6-dihydroxy-1-methylindole in good yield; the oxidation with silver oxide and subsequent isomerization with alkali reported by Burton[6] gave a poor yield of impure product.

The reaction has also been extended to halogen-substituted compounds. On treatment with potassium iodate, epinine gave a red crystalline iodo-quinone (I, $R_1 = I$, $R_2 = H$, $R_3 = Me$; m.p. 85–87° decomp.), which with zinc acetate gave pale yellow 5 : 6-dihydroxy-3-iodo-1-methylindole (II, $R_1 = I$, $R_2 = H$, $R_3 = Me$; m.p. 88–90° decomp.). That the iodine atom does not occupy the 2-position is shown by the fact that the diacetate (m.p. 146–147°) of our product differs from the diacetate[7] (m.p. 153–155°) of the isomeric 2-iodo compound.

2-Iodoadrenochrome[8] (I, $R_1 = OH$, $R_2 = I$, $R_3 = Me$) on treatment with zinc acetate and afterwards with sodium dithionite gave 3 : 5 : 6-trihydroxy-1-methylindole, the iodine atom being removed by the reducing agent.

In agreement with the Belgian authors[1], we have found that apart from aluminium, which, however, gives much less satisfactory results, zinc is the only metal the ions of which are effective in catalysing the rearrangement. It seems probable that the effect is due to the intermediate formation and subsequent decomposition of a zinc complex.



III

In support of this view, we have obtained an insoluble dark-green zinc complex (III) by the oxidation of catechol in the presence of zinc salts. As written above, it is represented as containing one benzenoid and one *o*-quinonoid nucleus, though, in fact, it is undoubtedly a resonance hybrid in which the two nuclei are in an equivalent intermediate state of oxidation.

Further work on this rearrangement, particularly with regard to the mechanism and possible biological significance, is in progress and will be reported in full elsewhere.

J. Harley-Mason
J. D. Bu'Lock

University Chemical Laboratory,
Cambridge. Aug. 24.

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Use of Lithium Aluminium Hydride in the Study of Carbohydrates

Structural studies of polysaccharides containing uronic acid residues involve the identification of the uronic acid and the determination of the manner in which it is joined to other sugar residues in the polysaccharide[1,2]. The identification of the uronic acid usually presents little difficulty if the modified methods of hydrolysis[3,4], coupled with chromatographic analysis[5,6], are applied. The nature of the linkage between the uronic acid residue and the other sugar components has been ascertained by periodate oxidation[7] and by methylation studies. The former method is of limited application whereas the latter, which involves the identification of a methyl derivative of the uronic acid, has been widely employed[2,8,9,10]. The identification can be time-consuming when reference substances are not available, and occasionally it presents difficulty inasmuch as removal of the glycosidic methyl group, which often forms part of the identification procedure, is accompanied by decarboxylation and decomposition.

A consideration of the properties of the methyl derivatives of uronic acids and of the corresponding sugars will show that if reduction of the carboxyl group at C_6 to a primary alcoholic group could be effected, the structural problem would be greatly simplified not only because the reduced compound would be more readily hydrolysed by acid and more stable during hydrolysis of the glycosidic group, but also because most of the partially methylated aldohexoses that would be formed have been characterized. This reduction step has been carried out in one or two cases by catalytic reduction[11,12,13], but, unfortunately, rather drastic conditions have to be applied, and not infrequently hydrogenolysis accompanies hydrogenation and the yield of the desired product is small.

We have recently found that lithium aluminium hydride ($LiAlH_4$), shown by others to reduce the carbonyl group[14,15,16], will also reduce the carbomethoxy group of uronic esters to a primary alcoholic group. The reduction proceeds rapidly at room temperature in inert solvents such as ether and tetrahydrofuran to give good yields. By this method we have reduced the methyl esters of 2 : 3 : 4-trimethyl methyl-D-galacturonoside, 2 : 3 : 4-trimethyl-α-methyl-D-glucuronoside and 4-methyl-methyl-D-glucuronoside[16,17] to 2 : 3 : 4-trimethyl-methyl-D-galactoside, 2 : 3 : 4-trimethyl-α-methyl-D-glucoside and 4-methyl-methyl-D-glucoside, respectively; the methyl ester of hexamethyl-6-β-D-glucuronosyl-β-methyl-D-galactoside has given 6-β-2 : 3 : 4-trimethyl-D-glucosyl-

2 : 3 : 4-trimethyl-β-methyl-D-galactoside (m.p. 145·5°, $[\alpha]_D$ − 39° in chloroform (*c*, 3·8); found : C, 51·8; H, 8·3; $C_{19}H_{36}O_{11}$ requires : C, 51·8; H, 8·3 per cent). Similarly, methylated pectic acid[18] gave a methylated galactosan, while methylated degraded arabic acid[19] afforded the corresponding neutral methylated polysaccharide, composed of methylated residues of galactose and glucose.

The reducing property of lithium aluminium hydride can be widely applied in carbohydrate studies, for free sugars and their derivatives and lactones and their derivatives can be readily reduced to the corresponding alcohols. For example, diacetone-mannose gave diacetone-mannitol, and 2 : 3 : 6-trimethyl-γ-D-mannonolactone afforded 2:3:6-trimethyl-mannitol.

Further details of this work will appear elsewhere.

Note added in proof. Since this work was completed Lythgoe and Trippett (*J. Chem. Soc.*, 1983 (1950)) have reported the use of lithium aluminium hydride for the reduction of the methyl ester of 2,3,4-trimethyl-methyl-D-glucuronoside.

M. Abdel-Akher
F. Smith

Division of Agricultural Biochemistry,
University of Minnesota,
St. Paul 1, Minnesota. Aug. 8.

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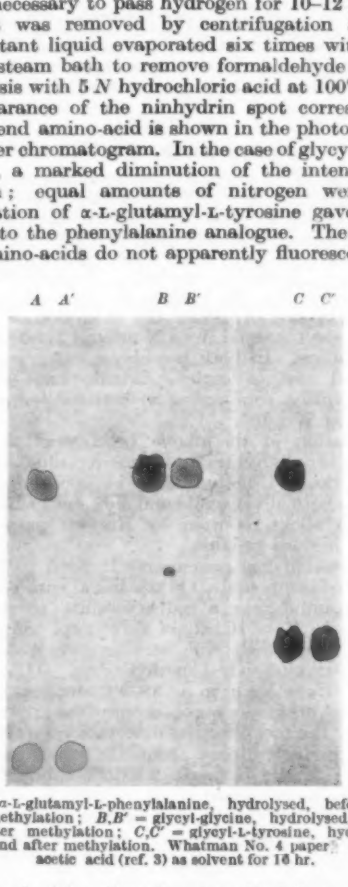
A Micro End-Group Method for Peptides

A method for the reductive methylation of peptides and amino-acids, recently published by Bowman[1], was used by him to identify as its N-dimethyl derivative the amino-acid in a peptide bearing the free amino-group. Advantage was taken of the ready solubility of these derivatives in alcohol. This elegant method is, however, not immediately suitable for micro-quantities. As N-dimethylamino acids do not give a colour with ninhydrin, paper chromatography[2] of the hydrolysate of a methylated peptide should show the absence of the end amino-acid when compared with the hydrolysate of the original peptide. Should this particular amino-acid also occur elsewhere in the peptide, then a diminution of the intensity of the relevant ninhydrin spot is to be expected.

It has so far been possible to test the method only on the following peptides : α-L-glutamyl-L-tyrosine, α-L-glutamyl-L-phenylalanine, glycyl-glycine, glutathione, glycyl-L-tyrosine ; it is hoped later to investigate other peptides.

0·2–0·5 c.c. of a 0·01 *M* solution of the peptide was poured into a 10-c.c. conical centrifuge tube fitted with a capillary gas inlet leading to the very tip of the tube. One drop of aqueous formaldehyde (40 per cent) and a 'knife-point' of palladized charcoal (5 per cent) were added and the tube placed in a thermostat at 40° C. The air was displaced by nitrogen and then a slow stream of hydrogen was passed into the suspension, followed again by nitrogen. Hydrogenation for 4 hr. was sufficient for the glycyl peptides, but in the case of the glutamyl peptides it was necessary to pass hydrogen for 10–12 hr. The catalyst was removed by centrifugation and the supernatant liquid evaporated six times with water on the steam bath to remove formaldehyde prior to hydrolysis with 5 *N* hydrochloric acid at 100° C.[3] The disappearance of the ninhydrin spot corresponding to the end amino-acid is shown in the photograph of the paper chromatogram. In the case of glycyl-glycine (*B*, *B'*), a marked diminution of the intensity can be seen ; equal amounts of nitrogen were used. Methylation of α-L-glutamyl-L-tyrosine gave results similar to the phenylalanine analogue. The methylated amino-acids do not apparently fluoresce on dry paper.



A,*A'* = α-L-glutamyl-L-phenylalanine, hydrolysed, before and after methylation ; *B*,*B'* = glycyl-glycine, hydrolysed, before and after methylation ; *C*,*C'* = glycyl-L-tyrosine, hydrolysed, before and after methylation. Whatman No. 4 paper ; butanol/acetic acid (ref. 3) as solvent for 16 hr.

The method has the advantage that it can be used in aqueous solution under very mild conditions, and that it requires a minimum of manipulation ; also there is no attack on tyrosine as in existing methods. On the other hand, this procedure cannot as yet be used for cysteine-containing peptides in which no methylation occurs. Probably any free amino-groups occurring in the side-chains of the peptide will also be methylated ; but after hydrolysis the corresponding amino-acid should still give a ninhydrin spot, though in a different position.

I acknowledge a grant from the Research Fund of the Chemical Society.

V. M. Ingram*

Department of Chemistry,
Birkbeck College Research Laboratory,
London, W.C.1. Aug. 25.

* Present address : Rockefeller Institute for Medical Research, New York, 21.

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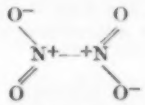
Potential Barrier in Dinitrogen Tetroxide

THE communication[1] by C. K. and E. H. Ingold on the structure of N_2O_4 reviews the chemical and physical evidence in favour of the various structures proposed for N_2O_4. The authors conclude that the structure is

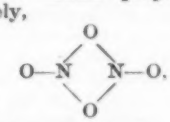


which is equivalent to the D_{2h} structure proposed by Sutherland[2] on the basis of the spectroscopic data. Using the fundamentals proposed by Sutherland and the following molecular dimensions, namely, $\angle$ ONO = 120°, r_{NO} = 1·15 A., r_{NN} = 1·66 A.[3], the entropy at 298° K. may be calculated by the usual methods of statistical thermodynamics[4]. In this way the entropy of translation for gaseous N_2O_4 at 298° K. is found to be 39·44 cal./deg./mole, and that due to vibration and rotation without taking torsion into account is 30·00 ± 0·3 cal./deg./mole. (The error of ± 0·3 E.U. in the rotational entropy is estimated by assuming that the error in each molecular dimension is ± 5 per cent.) The entropy observed by Giauque and Kemp[5] was 72·73 cal./deg./mole. Thus the amount of entropy contributed by the degree of freedom associated with internal rotation is 3·29 ± 0·3 cal./deg./mole. Assuming the potential energy is of the form $V = B/2\,(1-\cos 2\varphi)$ the torsional frequency and potential barrier B are related to the moment of inertia about the torsional axis by $\nu = \frac{1}{2\pi}\left[\frac{8B}{I}\right]^{1/2}$.

Then if the potential barrier is considered to be so high that the contribution to the entropy is simply due to a torsional oscillation, then the torsional frequency is 108 ± 20 cm.$^{-1}$, with a corresponding barrier of 8·5 ± 2 cal./mole.

On the other hand, if the barrier is not so high that a torsional oscillation may be used in the partition function, the tables of Pitzer and Gwinn[6] for a hindered rotator must be used. From these tables and the following values: $I_m = I/4 = 27{\cdot}5 \times 10^{-40}$ C.G.S. units, $n = 2$, $Q_f = 12{\cdot}6$, entropy of internal rotation = 6·06 E.U., and $S_f - S = 2{\cdot}77 \pm 0{\cdot}3$, it is found that the barrier is 9·2 ± 2 cal./mole. This corresponds to a frequency of 112 ± 20 cm.$^{-1}$. The barrier is evidently so high, ~ 9 ± 2 cal./mole, that both calculations yield very nearly the same result.

The molecular model proposed by Longuet-Higgins[7], namely,



with D_{2h} symmetry was introduced as an alternative to the ethylene-like structure of Sutherland to explain the spectrum and the abnormally long N—N distance[3] and low N—N force constant[8]. This model has no torsional mode, however, so that the calculated entropy and observed entropy differ by about 3 E.U. This lack of agreement is strong evidence for excluding this model as a possible structure.

Since the repulsion of the oxygen atoms would stabilize the out-of-plane form (D_{2d}), there must be a strong interaction ($\geqslant 9 \pm 2$ cal./mole) stabilizing the planar form. Resonance between the forms suggested by the Ingolds would be at a maximum when the structure is planar[9] and accounts for the stability of the planar form.

The heat capacity C_p° at 298° K. of N_2O_4 is calculated to be 17·11 cal./mole for a barrier of 9 cal./mole and 17·06 cal./mole for a completely hindered rotator. The available experimental results on the heat capacity of N_2O_4 are: 11·4 cal./mole at 307° K.[10] and 20 cal./mole at 300° K.[11]. An experimental redetermination of the specific heat seems to be indicated.

H. J. BERNSTEIN
W. G. BURNS*

Division of Chemistry,
National Research Council,
Ottawa. Aug. 10.

* National Research Laboratories Postdoctorate Fellow, 1945–50.

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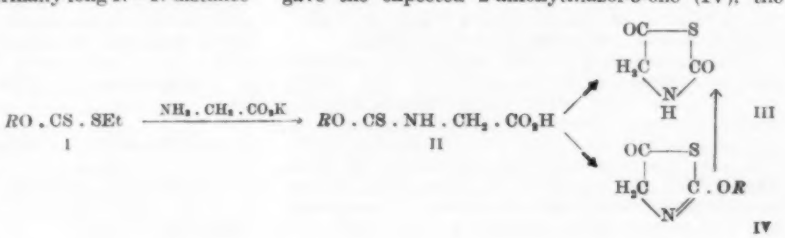
Synthesis of Thiazolid-2:5-Dione

RECENT interest in the synthesis of polypeptides has centred around the ability of oxazolid-2:5-dione and its 3- and 4-substituted derivatives to polymerize with loss of carbon dioxide or to condense with amino-acids or their esters. Cook and Levy[1] have now shown that the analogous 2-thiothiazolid-5-one and its 4-methyl derivative may also be used for the introduction of glycyl or alanyl residues. Attempts by Cook, Heilbron and Hunter[2] to obtain the structural cross of the above heterocycles, that is, thiazolid-2:5-dione (III), were unsuccessful. These authors were interested in the latter compound and its derivatives, as they considered they would be of a stability intermediate between that of oxazolid-2:5-dione and 2-thiothiazolid-5-one and would consequently be more easily handled. The parent compound has now, unexpectedly, been obtained in good yield by the accompanying reaction scheme.

A variety of potassium alkylxanthates (alkoxydithioformates) were esterified to give ethyl alkoxydithioformates (I), which condensed smoothly with potassium aminoacetate to give N-thiocarbalkoxyglycines (II). Cyclization of (II) with acetic anhydride gave the expected 2-alkoxythiazol-5-one (IV), the



reaction being quite analogous to the formation of 2-alkylthiothiazol-5-ones from N-dithiocarbalkoxyglycines observed by Cook, Harris, Heilbron and Shaw[2]. The attempted cyclization of (II) with phosphorus tribromide or trichloride gave a crystalline product which was not (IV) and which was formed irrespective of the nature of the alkyl group, *R*. The same product was obtained on treating (IV) in moist benzene with phosphorus trihalides. Its identity as thiazolid-2 : 5-dione was indicated by analysis (found : C, 31·2; H, 2·65; N, 11·6; S, 27·1 per cent; $C_3H_3O_2NS$ requires C, 30·75; H, 2·55; N, 11·95; S, 27·4 per cent). It forms inch-long laths (m.p. 110°) from water. Its aqueous solution decomposes on heating or prolonged standing to give an insoluble precipitate, believed to be polyglycine, and a gas containing labile sulphur.

PER AUBERT

Vei 2961, Smestad, Oslo.

E. B. KNOTT

Research Laboratories, Kodak, Ltd.,
Wealdstone, Middlesex. Aug. 18.

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Bleaching Reactions with Jute Fibre

BLEACHING of lignocellulosic materials with chlorine gas or with hypochlorous acid has been shown, in the case of unbleached wood-pulp[1], to take place through a series of reactions involving chlorination, demethoxylation and oxidation of the lignin. The reaction products are of relatively small molecular weight and are readily soluble in solutions of sodium sulphite. The rate of bleaching appears to depend upon the presence of the free phenolic or enolic hydroxyl group, known to exist in lignin, for Brauns[2] has shown, in the case of unbleached wood-pulp, that when this is blocked by a methoxyl group the rate of reaction of the lignin with a bleaching solution is greatly reduced.

Partial acetylation of jute with a mixture of acetic anhydride and pyridine, as well as methylation with an ethereal solution of diazomethane, has now been shown to lead to a similar retardation of the rate of bleaching. For example, while a lignin-free fraction can be isolated from raw jute, by the Cross and Bevan method, after three chlorinations and sulphite extractions, an acetylated sample requires as many as seven such treatments to achieve the same result. Moreover, the colour reactions associated with lignin after chlorination in acid solution and addition of sodium sulphite are much less marked with the acetylated sample. Unlike the non-acetylated material, in which an intense red colour develops in the cold immediately on adding sodium sulphite to the chlorinated lignin, the solution containing the acetylated material must be warmed, or even boiled, before any colour develops. The colour reactions can be restored to the acetylated sample by hydrolysing it with a cold solution of dilute alkali.

Another interesting property of partially acetylated jute is its behaviour to the action of light. While raw jute, like most other lignocelluloses, becomes yellow or brown on exposure to light, similar treatment of a partially acetylated sample results in photochemical bleaching and there is a loss of acetyl groups from the sample[3]. A comparison of the bleaching-rates, and colour reactions, of acetylated jute before and after exposure to the light of a mercury-vapour lamp has therefore been made. Since this leads to no change in either bleaching-rate or colour reactions, it is clear that those acetyl groups removed during irradiation are not those primarily responsible for retarding the bleaching reactions of acetylated jute.

I wish to thank the Executive Committee of the Indian Jute Mills Association Research Institute, which sponsored this work.

H. J. CALLOW

Department of Textile Industries,
University, Leeds.
Aug. 26.

[1] White, E. V., Swartz, J. N., Peniston, Q. P., Schwartz, H., McCarthy, J. L., and Hibbert, H., *Tech. Assoc. Pap.*, **24**, 179 (1941).
[2] Brauns, F. E., *Paper Trade J.*, **103**, 36 (1936).
[3] Callow, H. J., *Nature*, **159**, 309 (1947).

Chess-playing Machines

IN the account in *Nature* of October 14 of machines which carry out strategic sequences of moves, it is stated : "No machine can learn from its mistakes—to improve the play the programme must be improved"[1]. It is, of course, true that a machine cannot learn unless it is provided with a programme or mechanism for learning. But it is quite possible to devise such a mechanism.

Machines can be designed to make the best move at each step in a game of noughts-and-crosses or (in theory) draughts or chess. But when playing against a series of human opponents, such a machine may never do much better than draw. A good human player against the same opponents may score more wins by making unsound but more puzzling moves. Can a machine be made to imitate the human player? Instead of playing perfectly, can it be made to play well? It can, by the inclusion of an empirical or statistical mechanism, in three units. One unit makes the machine experiment with different alternatives each time certain positions are reached; the second unit counts the results and relates them to the alternatives chosen; and the third steers the machine into the lines of play which have been winning most often.

Indeed, the mechanism may be made more subtle. The second unit could also be made to classify players, say by their opening moves, into the bold and the timid. The third unit would then, in a given end game, choose the move which had won most often against players of that type.

Thus it is possible to programme a machine so that it learns, matures and even develops a style. We do so by putting in a mechanism which estimates the probability of success in the future by analysing the distribution of successes in the past. Perhaps this is not the way in which animals learn; or perhaps, on the contrary, it is the very reason why animals play games at all. But I am confident that the inclusion of such statistical mechanisms will be an important development in machines. I can speak for its usefulness in strategic problems, for I myself used it in a rudimentary form in bombing studies, in those spacious days when we worked with punched cards.

J. BRONOWSKI

Central Research Establishment
of the
National Coal Board.
Oct. 15.

[1] *Nature*, **166**, 644 (1950).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 18

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Have Post-War Broadcast Receivers taken Full Advantage of War-time Development?" (to be opened by Mr. R. B. Armstrong).

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Dr. V. E. Fuchs: "Latest Explorations in British Antarctica".

Tuesday, December 19

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. H. H. Green and Dr. Ruth Allcroft: "Copper-Molybdenum Relationships in Disorders of Ruminants".*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Paul Bloomfield: "The Ideal of an Elite".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Prof. R. H. Evans: "Research and Developments in Pre-Stressing" (Unwin Lecture).

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. T. Nigel Browne: "Parts of Southern Italy".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. A. Fowler Williams: "A New Monomer, Acenaphthylene; its Polymers and Copolymers".

Wednesday, December 20

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. G. K. Batchelor: "The Application of the Similarity Theory of Turbulence to Atmospheric Diffusion"; Mr. J. M. Craddock: "Advective Temperature Change in the 1000–700 mb and 700–500 mb Layers".

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "The Comparative Biology of Natural Fibres".

INSTITUTE OF PETROLEUM, STANLOW BRANCH (joint meeting with the LIVERPOOL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Grosvenor Hotel, Chester), at 7.15 p.m.—Apparatus Symposium.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the following dates:

ASSISTANT PHYSICIST at the Royal Northern Hospital and Prince of Wales General Hospital Joint Radiotherapy Centre—The Secretary, Northern Group Hospital Management Committee, Royal Northern Hospital, Holloway, London, N.7 (December 23).

CHEMIST (with a good honours degree or equivalent professional qualification) in the Executive's Laboratory Service at Chiswick, responsible to a senior chemist for the work of a small section dealing with paints—The Staff Officer, London Transport Executive, 55 Broadway, London, S.W.1, quoting F/EV.149 (December 23).

EXPERIMENTAL OFFICER (with a university degree in botany or agriculture, and a recognized agricultural diploma)—The Honorary Director, Unit of Experimental Agronomy, Department of Agriculture, The University, Oxford (December 23).

LECTURER (Grade II) IN METALLURGY—The Secretary, The University, Birmingham 3 (December 23).

SENIOR LECTURER IN QUANTITY SURVEYING, and STUDIO MASTERS (3), for the School of Architecture, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 23).

SUPERINTENDENT (Protective Coatings) IN THE EXECUTIVE'S RESEARCH DEPARTMENT at Derby—The Secretary, Railway Executive, 222 Marylebone Road, London, N.W.1 (December 23).

LECTURER IN CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (December 27).

ASSISTANT INSPECTOR (Forestry) IN THE MINISTRY OF AGRICULTURE—The Secretary, Civil Service Commission, Stormont, Belfast (December 29).

SCIENTISTS, Grade III (with a good honours degree in chemistry), IN THE COAL SURVEY LABORATORIES at Chester and Sheffield—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/274 (December 29).

PHYSICIST or ENGINEER to undertake development work in connexion with electronic apparatus for spray assessment—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (December 30).

PRINCIPAL OF THE EGERTON SCHOOL OF AGRICULTURE, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/266 (December 30).

SENIOR EXPERIMENTAL OFFICERS, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS at Admiralty Experimental Establishments in the vicinity of London, Baldock, Greenock, Haslemere, Portsmouth, Rosyth and Weymouth: MECHANICAL ENGINEERS (Ref. No. C.632/50A) who have had research and development experience in light mechanisms, ELECTRICAL ENGINEERS (Ref. No. D.368/50A) who have had experience in telecommunications, radar, electronics or light electrical mechanisms, PHYSICISTS (Ref. No. A.335/50A) interested in general physical problems, electronics or acoustics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (December 30).

SENIOR LECTURER or LECTURER IN PREVENTIVE MEDICINE AND PUBLIC HEALTH—The Registrar, The University, Leeds 2 (December 30).

SENIOR PSYCHOLOGIST to the East African Institute of Social Research attached to Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 30).

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS at Admiralty Experimental Establishments in the vicinity of London, Baldock, Greenock, Haslemere, Portsmouth, Rosyth and Weymouth: PHYSICISTS (Ref. No. A.336/50A) capable of undertaking research or development in general physical problems, electronics, acoustics or thermodynamics, ELECTRICAL ENGINEERS (Ref. No. D.367/50A) qualified to undertake research, development or design in telecommunications, radar, electronics, instrumentation or light electrical mechanisms, MECHANICAL ENGINEERS (Ref. C.631/50A) capable of design, development or research work in light mechanisms, structures or hydrodynamics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (December 30).

ANALYST to take charge of regular chemical analyses of water samples—The Director, Freshwater Biological Association, The Ferry House, Faw Sawrey, Ambleside, Westmorland (December 31).

LECTURER IN BOTANY (preferably in the special fields of either plant physiology or mycology) at Malaya University—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 31).

PLANT PATHOLOGIST in the Department of Agriculture, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/267 (December 31).

PROFESSIONAL ENGINEERS in many Departments of the Civil Service, for a wide variety of engineering duties—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3225 (December 31).

PROFESSOR OF AGRICULTURE (Soil Science) at the Canterbury Agricultural College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 31).

PRINCIPAL SCIENTIFIC OFFICER to be responsible under the Superintending Scientist, Propulsion Research Laboratory, Adelaide, for organizing the Engineering Group of the Laboratory, etc.—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (January 2).

SUGAR CANE EXPERT in the Department of Agriculture, Peradeniya—The Office of the High Commissioner for Ceylon in the United Kingdom, 13 Hyde Park Gardens, London, W.2 (January 5).

SCIENTIST, GRADE II (with a good university honours degree or its equivalent in chemistry) on the staff of the Director of Scientific Control at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/278 (January 6).

HENRY BELL WORTLEY CHAIR OF METALLURGY—The Registrar, The University, Liverpool (January 13).

SCIENTIST, Grade III (with a good honours degree (or equivalent) in mathematics, physics or engineering) in the Field Investigation Group of the Directorate of Scientific Control—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/279 (January 13).

HEAD OF THE DEPARTMENT OF CHEMISTRY AND BIOLOGY, Liverpool College of Technology—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (January 15).

LECTURER IN ANATOMY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 15).

MUSEUM ASSISTANT IN THE GEOLOGY DEPARTMENT—The Secretary, University College, Gower Street, London, W.C.1 (January 15).

PROFESSOR OF CIVIL ENGINEERING at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 15).

LECTURER IN PHYSICS at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 22).

GARDINER CHAIR OF BACTERIOLOGY—The Secretary of University Court, The University, Glasgow (January 30).

COW AND GATE FELLOWSHIP for research into problems associated with nutrition in infants and children—The Registrar, The University, Manchester 13 (January 31).

PROFESSOR OF APPLIED MATHEMATICS at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF ASTRONOMY, Australian National University—The Administrative Officer in the United Kingdom, 27 Russell Square, London, W.C.1 (February 1).

SENIOR LECTURER IN CHEMICAL PATHOLOGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 1).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary, The University, Edinburgh (March 1).

PROFESSORSHIP IN THE DEPARTMENT OF PHYSICS—The Registrar, University of Manitoba, Winnipeg, Canada (March 31).

ASSISTANT PROFESSOR OF ANATOMY—The Dean, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada.

CHEMIST or BIOCHEMIST (with first- or second-class honours) for research in animal nutrition, with special reference to dietary factors affecting digestion—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

COMPUTER to undertake computation of geodetic, astronomical and cadastral surveys and the preservation of records, in H.M. Colonial Service, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27076/41.

DESIGN ENGINEERS to design and develop special small mechanisms, gadgetry and process tools (work will mainly consist of designing and developing apparatus for the remote handling of substances through various manufacturing processes)—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

GEOPHYSICIST (graduate in science and/or mining engineering) in the Mines Department of South Australia—The Agent-General for South Australia, Marble Arch, London, W.1.

JUNIOR and SENIOR ASSISTANTS FOR THE CHEMICAL RESEARCH LABORATORY, Rheumatism Unit, Nether Edge Hospital, Sheffield—The Chief Administrative Officer, United Sheffield Hospitals, The Royal Hospital, Sheffield 1.

PLANT BREEDERS IN THE DEPARTMENT OF AGRICULTURE, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/44.

PLANT GENETICIST to carry out research on the genetics of sisal at the Sisal Research Station, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/171.

RESEARCH OFFICER (with honours degree in chemistry) to undertake work on the behaviour of coals during utilization in relation to their structure and constitution, and an ASSISTANT CHEMIST for the physical chemistry section—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

SENIOR PHYSICIST, attached to the Radiotherapy Department—The Secretary, London Hospital, Whitechapel, London, E.1.

SENIOR SCIENTIFIC OFFICER (with experience in some branch of textile research) IN THE CHEMISTRY DEPARTMENT—The Director of Research, Linen Industry Research Association, Lambeg, Co. Antrim.

SURVEYOR to carry out special duties in charge of levelling in Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27076/23.

TECHNICAL CHEMIST (with a first-class degree in technical chemistry and some industrial experience)—The Divisional Controller, British Electricity Authority, South East Scotland Division, British Electricity House, Portobello, Midlothian.

TECHNICAL LIBRARIAN (with a good honours degree in science) in the Division of Atomic Energy (Production), Windscale Works, Sellafield, Cumberland, to organize and supervise a scientific library, a scientific and technical information bureau and ancillary services of a large research department—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Agricultural Research Institute of Northern Ireland. Twenty-third Annual Report, 1949–1950. Pp. 43. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1950.) [209

Library Association. Pamphlet No. 3: Library Binderies. By R. F. Drewery. Pp. 40+4 plates. (London: Library Association, 1950.) 3*s.* 6*d.*: 2*s.* 9*d.* to members. [209

Ministry of Fuel and Power. Report of the Committee of Inquiry into the Precautions necessary to secure Safety in the use of Explosives in Coal Mines. Pp. 52. (London: H.M. Stationery Office, 1950.) 1*s.* 6*d.* net. [209

The Star Almanac for Land Surveyors for the Year 1951. Prepared by H.M. Nautical Almanac Office. Pp. xiii+66. (London: H.M. Stationery Office, 1950.) 3*s.* net. [209

Colonial Office. Colonial Road Problems: Impressions from Visits to Nigeria. By H. W. W. Poillit. (Colonial Research Publications No. 8.) Pp. viii+36+34 plates. (London: H.M. Stationery Office, 1950.) 3*s.* net. [209

Philosophical Transactions of the Royal Society. Series A: Mathematical and Physical Sciences. No. 856, Vol. 242: Diffraction from an Irregular Screen with applications to Ionospheric Problems. By H. G. Booker, J. A. Ratcliffe and D. H. Shinn. Pp. 579–609. (London: Cambridge University Press, 1950.) 6*s.* 6*d.* [219

Philosophical Transactions of the Royal Society. Series B: Biological Sciences. No. 618, Vol. 234: The Motor Nervous System of the Starfish, *Asteropecten irregularis* (Pennant), with special reference to the Innervation of the Tube Feet and Ampullæ. By J. R. Smith. Pp. 521–558. (London: Cambridge University Press, 1950.) 10*s.* 6*d.* [219

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1948–49. Pp. 26. (London: H.M. Stationery Office, 1950.) 2*s.* net. [219

Colonial Office. Annual Report on the East Africa High Commission, 1949. (Colonial No. 263.) Pp. ii+40+4 plates. (London: H.M. Stationery Office, 1950.) 1*s.* 6*d.* net. [310

Colonial Office: Colonial Advisory Council of Agriculture, Animal Health and Forestry. Publication No. 1: Report of a Survey of Problems in the Mechanization of Native Agriculture in Tropical African Colonies. Pp. ix+124+16 plates. (London: H.M. Stationery Office, 1950.) 4*s.* 6*d.* net. [310

Colonial Office. Report by H.M. Government in the United Kingdom of Great Britain and Northern Ireland to the General Assembly of the United Nations on the Administration of the Cameroons under United Kingdom Trusteeship for the Year 1949. (Colonial No. 262.) Pp. xvi+384+8 plates. (London: H.M. Stationery Office, 1950.) 10*s.* 6*d.* net. [510

Bulletin of the British Museum (Natural History). Entomology. Vol. 1, No. 4: The Type Specimens of certain Oriental Eucosmidæ and Carposinidæ (Microlepidoptera) described by Edward Meyrick, together with Descriptions of New Eucosmidæ and Carposinidæ in the British Museum (Natural History.) By A. Diakonoff. Pp. 273–300+plates 3–8. (London: British Museum (Natural History), 1950.) 8*s.* [510

National Association of Girls' Clubs and Mixed Clubs. Annual Report, 1949 to 1950. Pp. 48. (London: National Association of Girls' Clubs and Mixed Clubs, 1950.) [510

Other Countries

Service des Antiquités de l'Egypte. Some Applications of Statistics to Archæology. By Oliver H. Myers. Pp. vi+37+19 plates. (Cairo: Government Press, 1950.) P.T. 120. [209

United States Department of Commerce: Weather Bureau. Technical Paper No. 1: 10-Year Normals of Pressure Tendencies and Hourly Station Pressures for the United States. Pp. v+72 charts. (Washington, D.C.: Government Printing Office, 1943.) [209

Australian Journal of Applied Science. (4 times a Year.) Vol. 1, No. 1, March. Pp. 132. (Melbourne: Government Printer, 1950.) 30*s.* per annum. [209

Transactions of the American Philosophical Society. New Series, Vol. 40, Part 1: Geology of the Coastal Plain of North Carolina. By Horace G. Richards. Pp. 83. (Philadelphia: American Philosophical Society, 1950.) 1·50 dollars. [209

Smithsonian Institution: United States National Museum. Bulletin 197: Life Histories of North American Wagtails, Shrikes, Vireos and their Allies; Order Passeriformes. By Arthur Cleveland Bent. Pp. vii+411+48 plates. (Washington, D.C.: Government Printing Office, 1950.) 1·50 dollars. [209

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. Pp. 26. (Washington, D.C.: Smithsonian Institution, 1950.) [209

United States Department of Agriculture. Farmers' Bulletin No. 1990: Habits and Control of the Fall Armyworm. By Philip Luginbill. Pp. ii+11. n.p. Leaflet No. 144: Cockroaches and their Control. Revised edition. Pp. ii+9. 10 cents. Leaflet No. 182: House Fly Control. By F. C. Bishopp and L. S. Henderson. Revised edition. Pp. 8. 10 cents. Leaflet No. 274: Control of Apple Tree Borers. Pp. ii+6. 5 cents. (Washington, D.C.: Government Printing Office, 1950.) [209

The Natural Forest Inviolate Plot, Akure Forest Reserve, Ondo Province, Nigeria. By the late A. P. D. Jones. Pp. iii+33. (Ibadan: Nigerian Forest Department, n.d.) [209

State of California Department of Natural Resources. Fortieth Biennial Report of the Division of Fish and Game for the Years 1946–1948. Pp. 118. (Los Angeles: Department of Natural Resources, 1949.) [209

World Health Organization. Technical Report Series No. 19: Yellow-Fever Panel: Report on the First Session. Pp. 9. (Geneva: World Health Organization; London: H.M. Stationery Office, 1950.) 9*d.*; 10 cents. [209

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Proces-verbaux des Réunions. Vol. 126: Rapport Atlantique; Réunion des experts du Conseil International pour l'Exploration de la Mer, à Biarritz, 20–26 Avril 1948. Biologie des clupéidés (le hareng excepté). Publié avec l'aide de Jean le Gall. Pp. 126. 20 kr. Bulletin statistique des pêches maritimes des Pays du nord et de l'Ouest de l'Europe. Vol. 31, pour les années 1945–1946. Rédigé par Nils Rosén. Pp. xii+61. 8 kr. Bulletin hydrographique pour les années 1940–1946, avec un appendice pour les années 1936–1939. Pp. viii+190. 30 kr. (Copenhague: Andr. Fred. Host et fils, 1950.) [209

United Nations: Commission on Human Rights. Definition and Classification of Minorities. Pp. iv+51. (Lake Success, N.Y.: United Nations; London: H.M. Stationery Office, 1950.) 40 cents: 3*s.* [209

Research Council of Israel. Research on Loading Tests of Reinforced Concrete Floor Structures; Report of Work carried out at the Standards Institution of Israel. By M. A. Arnan, M. Reiner and M. Teinowitz. Pp. 54. (Jerusalem: Research Council of Israel; New York: Interscience Publishers, Inc.; Amsterdam: North-Holland Publishing Co., 1950.) 150 prutot; 3*s.* [209

Meddelanden från Oceanografiska Institutet i Göteborg. 17: Zur Sedimentation und Geochemie im aequatorialen atlantischen Ozean. Von F. F. Koczy. Pp. 45. (Göteborg: Elanders Boktryckeri A.-B., 1950.) [219

Svenska Hydrografisk-Biologiska Kommissionens Fyrskeppsundersokning. År 1946–1947. Pp. 80. (Göteborg: Elanders Boktryckeri A.-B., 1950.) [219

Annalen van de Sterrewacht te Leiden. Deel 20, Derde Stuk: Estimates of 64 Variable Stars on Plates of the β Centauri Region, taken by the late H. Van Gent. By Ejnar Hertzsprung. Pp. 117–172. Deel 20, Vierde, Vijfde, Zesde en Zevende Stuk: Discussion of the 31 Variable Stars in or near the Constellation Scutum, by G. A. Bakos; A Study of 25 Variable Stars in Monoceros, by H. G. van Bueren; Note on 19 New Variable Stars in the Region around II Puppis, by E. van den Hoven van Genderen; Discussion of 35 Variable Stars in the Region around CPD $-49°$ 2484, by C. J. van Houten. Pp. 175–240. (Haarlem: Joh. Enschedé en Zoon, 1950.) [219

Catalogues

Plant Growth Substances. No. 5. Pp. 16. (London: Pal Chemicals, Ltd., 1950.)

Progress. Vol. 41, No. 228, Autumn. Pp. 48. (London: Lever Brothers and Unilever, Ltd., 1950.)

Plant Protection Overseas Review: a Periodical Survey of New Developments in the Control of Pests, Diseases and Weeds. Vol. 1, No. 4, September. Pp. 24. (London: Plant Protection, Ltd., 1950.)

Solex Air Operated Gauging. Catalogue A.1: General Catalogue. Pp. 16. Catalogue D.1: Production Gauging Equipment—External. Pp. 8. Catalogue E.1: Production Gauging Equipment—Internal. Pp. 12. (London: Solex (Gauges), Ltd., 1950.)